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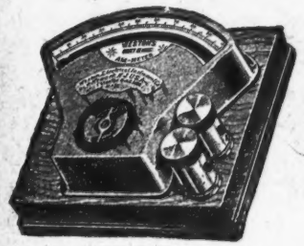

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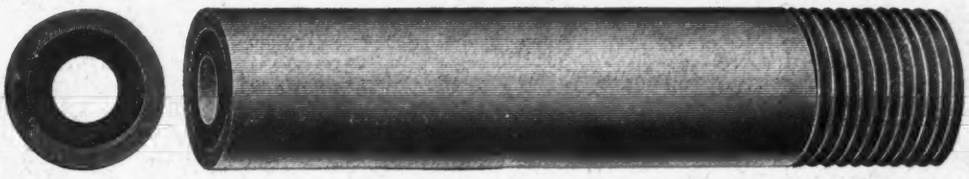

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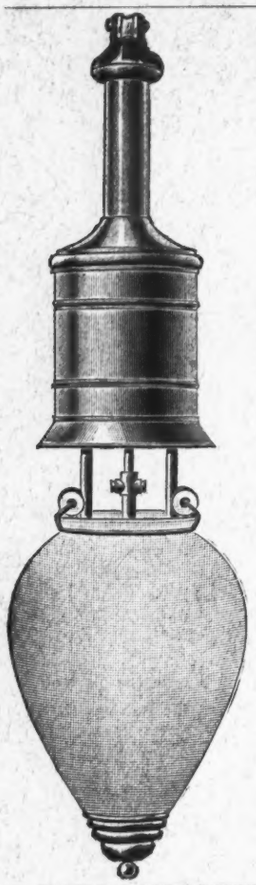

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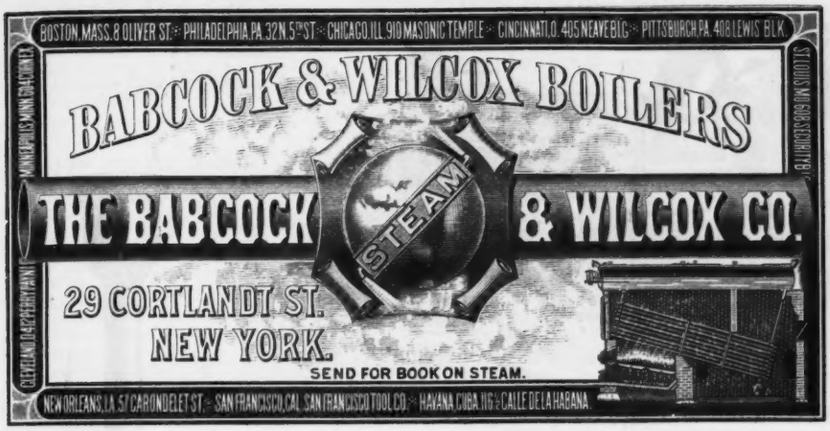
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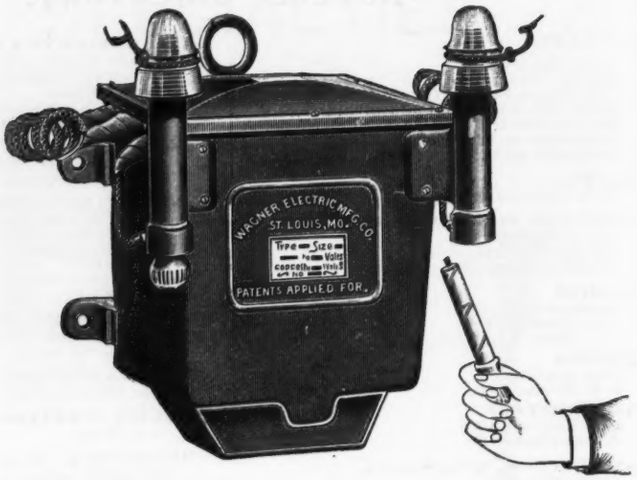

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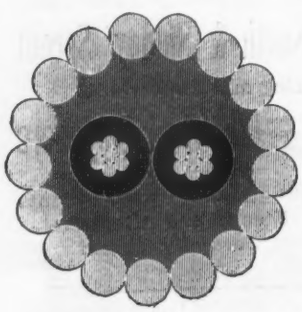

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The Journal of Electricity

VOL. II. APRIL, 1896. No. 4

The Fresno Transmission Plant

BY GEO. P. LOW

ONE of the first surprises experienced by the visitor to the power house of the San Joaquin Electric Company results from standing him opposite the wheel house of one of the Pelton wheels within the pit while the attendant in the station starts up the equipment, and the nerves of the visitor must be strong if they can restrain him from fleeing terror stricken from the heavy "cannonading" that accompanies the starting of the plant. He is, of course, aware that the installation is operated under a higher head of water than any other electric transmission plant in the world, but he is not prepared for an outburst resembling that of artillery, and his first thought will be that something is wrong—that the enormous receiver beside him is breaking away, and that but a moment stands between him and eternity, but he finds his distress a source of amusement to the station hands, and his chagrin secures satisfaction in the determination that he will get some one else in the same predicament, and "have the laugh on him." In truth he has received his first lesson of the terrific energy represented in a column of water which throws the gauge to above 600 pounds, and the rattle as of the "machine guns" is readily explained by the fact that while idle the chamber of the nozzle is filled with air, and upon opening the gate, the water rushes in, filling the lower portion of the nozzle first, then compressing the air in the upper part, and in the churning of the air that follows, bubble after bubble of air compressed to over 600 pounds per square inch is released, forming a discharge of pneumatic musketry, that, reverberating through the canyons, bears tidings to the ranchers even six miles distant, of the starting of the water wheels.

THE CANAL AND RESERVOIR.

Nature appears to have foreseen the necessities

FIGURE 1—VIEW OF RESERVOIR MOUNTAIN, PIPE LINE AND POWER HOUSE SITE OF SAN JOAQUIN ELECTRIC COMPANY.

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which have led to the development of water powers and their utilization by the means of electricity, and the hand of man could not have executed a more favorable plan than that upon which the water power of the San Joaquin Electric Company has been developed. High in the Sierras and well within the winter snow line, the North Fork of the San Joaquin River makes its precipitous descent to the valleys below. Until well in the summer, each valley adds its quota of water to the stream, but only the waters from the larger canyons have perennial flow. Of these, the North Fork and the South Branch of the North Fork of the San Joaquin River, were selected as head waters. No dam or structure of any sort other than simple fluming marks the diversion points, the flumes being simply extended into the banks at the side of the streams, or are well bolted to bedrock, and continue thence to their confluence shown in Figures 2 and 3. The canal thus formed is about seven miles in length, of which 3,000 feet is of wood flume, and the remainder is ditching. Waste gates have been placed in the canal at every 4,000 feet, and the canal has a capacity of 70 cubic feet of water per second.

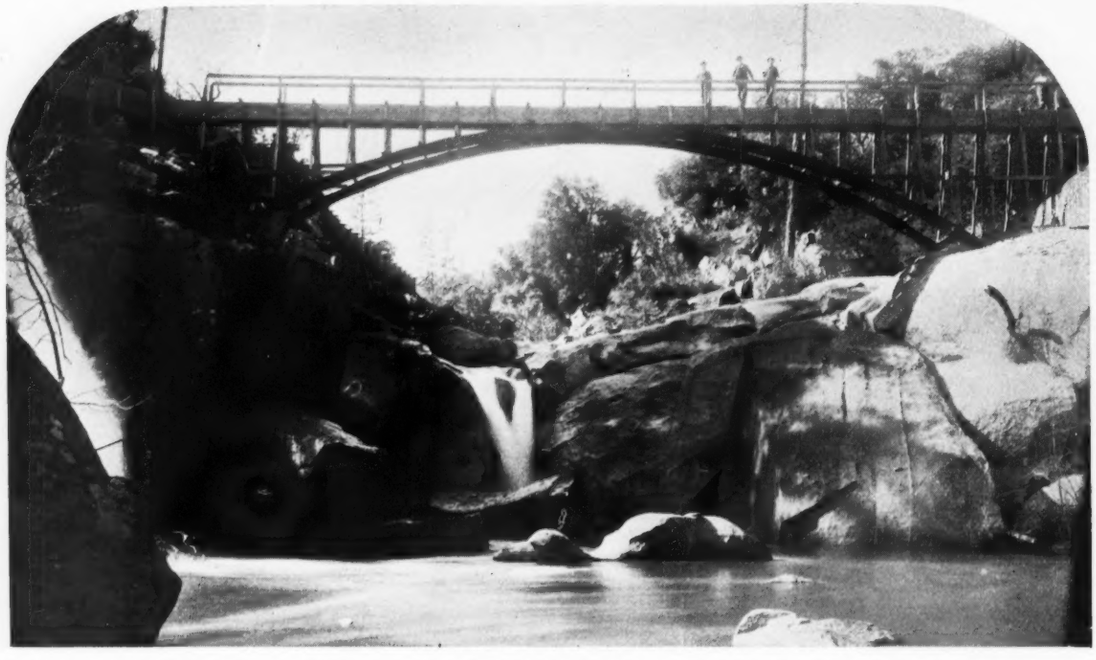


FIGURE 2—ARCH FLUME STRUCTURE OVER THE NORTH FORK OF THE SAN JOAQUIN RIVER, SHOWING CONFLUENCE OF THE DIVERSION FLUME INTO THE MAIN FLUME.

A great portion of the flume has been built on solid rock, forming the bed of the river. The severe freshets that occur during the winter months necessitate the utmost rigidity in securing the flume to the rock. This was done by anchor bolts consisting of heavy iron split at the end for from four to five inches, and into which steel wedges were started. The bolts, with the wedges started, were then driven into holes that had been drilled into the solid granite, and the spreading thus caused by the wedge rendered the withdrawing of the bolt practically impossible, but greater security was given by filling the holes with melted lead. So firm has this construction proven that the storms and freshets of the past winter have not affected the flume in any way. The ditch is built throughout in a reddish loam, which settles and packs so that no seepage occurs. A portion of the ditch is shown in Fig. 4.

THE RESERVOIR

An interesting feature in the development of the water power consists in the peculiar topographical formation of the ridge upon which the reservoir has been located. This ridge extends out as a spur from the backbone of the main North Fork Ridge, and is bounded on one side by the North Fork of the San Joaquin and on the other by Fish Creek. It is around this main ridge that the canal is carried, and Reservoir Mountain, as the spur ridge is aptly termed, consists practically of a table land with three sides very precipitous. The location of the reservoir, together with its elevation, is clearly shown in Figure 5. In the background are seen ridges of the main chain of mountains, while in the valley between them and the reservoir runs the San Joaquin River. The area of the reservoir is about eight acres, and it was formed by throwing up an earth embankment to a height of eight or ten feet for a distance of about 500 feet. Its storage capacity is sufficient to operate the transmission plant to full capacity for between five and six days.

The favorable location of the reservoir can be better understood by reference to Figures 1 and 5, which are really companion photographs. Figure 1 is made from a photograph taken well down on the mountain side shown in Figure 15 and the reservoir is directly over the crest at the top of the mountain in Figure 1. Water may be supplied to the pipe line either from the reservoir or direct from the flume, an additional 800 feet of which has been constructed to subserve this purpose. The head of the pipe line, together

with bifurcating gates, pressure box and air stand pipe, is shown in Figure 6.

The pipe line consists of practically three sections, according to the variety of pipe used. The first 1820 feet is of riveted pipe, 24 inches in diameter, the first 960 feet of which is of No. 12 steel, and the remainder is of one-fourth inch steel. Then follows the second section, consisting of 400 feet of standard converse lock-joint welded pipe 20 inches in diameter and having lead joints. The last section, which is also 1,800 feet in length and has a diameter of 20 inches, consists of lap-welded pipe, with flange joints made tight with rubber packing. The entire length of the pipe line to the receiver is, therefore, 4,020 feet. The first section was built by the Risdon Iron and Locomotive Works, and pipe for the remaining sections was furnished by the Dunham, Carrigan & Hayden Company, and was made by the National Tube Works of McKeesport, Pa.

FIGURE 3—ANOTHER VIEW OF THE CONFLUENCE OF THE DIVERSION FLUMES, SHOWING SITE OF THE NORTH FORK DIVERSION, A PORTION OF THE DITCH AND FLUME OF THE SOUTH BRANCH OF THE NORTH FORK DIVERSION AND AN OVERFLOW GATE IN THE MAIN FLUME.

As stated, water may be conveyed to the pipe line either from the reservoir or the canal direct and to prevent litter from being carried down the line, the openings of the pipe lines leading to the pressure box have been provided with bell mouths, each 6 feet in diameter across the mouth and covered by a massive screen containing 1,800 one-half inch holes. From the pressure box a 12-inch stand pipe, with suitable valves, extends to a point above the level of the reservoir. The bifureating gates, as well as all other gates and relief valves, are of Risdon make.

Much difficulty was experienced from unappreciated causes in the erection of the pipe line, and being about 4,000 feet in length and running over different geological formations various expedients had to be resorted to to secure stability. At some portions the pipe line has been buried to a depth of from five to eight feet in the soil. Elsewhere it is supported on short bridgings but the general construction consists of bolting the pipe firmly to the massive granite bed-rock. Stay rods, or holding-back bolts, are not used, but instead the pipe is held down in the manner above described for holding down the flume. With the pipe line, however, the split bolts are sulphured into the granite to a depth of from five feet to seven feet, and to the bolts are screwed semi-circular, flat iron bands, $2\frac{1}{2}$ inches by $\frac{5}{8}$ths inch in size, placed on top of the pipe.

The pipe line was built from the ends towards the center and as the time for closing in the gap approached a new obstacle appeared. Early in the morning, before sunrise, the gap between the pipe ends, and which is best termed "the cold gap," was 7 feet 8 inches. In the afternoon, and about sunset, this gap would close to exactly 7 feet, giving "the hot gap" due to the expansion of the pipe by the heat of the sun.

Section 1, consisting of 24-inch riveted pipe, was built first, the construction being begun at the lower terminus and laid from the bottom upward, the pipe being held in place with heavy timbers known, by boiler-maker s as "dead men." The lap welded or 20-inch pipe was laid from the receiver upwards, leaving a gap between the reducer

FIGURE 4—A PORTION OF THE MAIN DITCH.

piece or taper joint on the riveted pipe and the last bell of the converse lock joint pipe. Early in the morning, before sunrise, this gap, best termed "the cold gap," was 7 feet 8 inches. In the afternoon, and about sunset, the gap would close to exactly 7 feet, giving "the hot gap" due to the expansion of the pipe by the heat of the sun. The closing of the gap was thus resolved into the problem of finding the minimum temperature of the pipe, then closing the opening and filling the pipe with water before sunrise. All tools and materials were gotten ready, and at 2:30 a. m. the gap measurement was taken, a piece of lap welded tubing was cut to fit and then driven in place tightly. A loose bell was used and the rib chipped out so that it slipped freely over the edge of the pipe at the point of splicing, and when the connecting piece was in place and slipped over, the joint was filled with lead on both sides and caulked, thus completing the pipe.

FIGURE 5—CREST OF RESERVOIR MOUNTAIN, SHOWING RESERVOIR AND FLUME LEADING THERETO.

One is not to be disappointed in the natural expectation that the installation and operation of a pipe line of this character would be attended by many peculiarities if not phenomina entirely new. Operated as it is, under a head of 1,411 feet, and having imposed upon it the trying conditions incident to the control of hydrostatic pressure of 609 pounds per square inch, the requirement that electric generators shall be operated at a practically uniform speed necessitates the exercise of the greatest ingenuity in the design of water wheel governors and the San Joaquin pipe line, being strictly the pioneer in this direction, has had imposed upon it both the use and abuse that would naturally fall upon the first undertaking of the kind. It is with a view that the difficulties experienced may be obviated in future installations of this character that considerable space is given to them.

Students of accoustics may care to know that to halloo into the mouth of the empty pipe line invariably causes seven distinct echoes. The normal flow of water in the pipe is at the rate of 1½ feet per second, and the present plant in the station, when operated to full capacity, does not consume sufficient water to enable the determination of the friction head. The velocity of the water from the 1⅛ inch nozzles used is something over 9,200 feet per minute, and nothing is more impressive of the terrific energy of water at this head than a recital of some of the difficulties that have been encountered in controlling it. The general features of construction that have become well established by the erection of many plants operating under heads of from 500 to 600 feet or less were first carried out in this installation, but subsequent experiences compelled their

FIGURE 6—BIFURCATING GATES, PRESSURE BOX AND AIR STANDPIPE AT THE HEAD OF THE PIPE LINE.

abandonment and the design of special features to satisfy the conditions found to exist. In the wheel pit for instance, and in the tail race all masonry construction is of the most solid character. The wheel pit was carefully closed over by heavy planking, and upon turning on the water it refused to go out the tail race and along the bottom of the ditch, but instead rolled up the sides of the pit or followed up the water wheels to the plank covering and along the under side of the planks it rushed madly out, almost horizontally, for a distance of sixty feet, where it struck a great granite boulder, and was lost in spray.

The jets strike the wheels at an angle of 45 degrees from the horizontal, and, the nozzles being deflecting, the impact water strikes the bottom of the wheel pit with terrific fury. After two days operation the water had cut 3 feet about the nozzle with ⅜-inch steel plates. At that time the water was slightly muddy and considerable granite sand had been washed into the tail race and as a result in less than three days a ¼ inch jet which had been left in, had worn its way through the steel plate and the 3-inch planking, and was at work upon the demolition of its old enemy, —concrete and masonry. The heroic method of feeding a fresh cast-iron plate 1½ inches in thickness to it as often as necessary has now been resorted to as the best solution of the problem.

SOME EXPERIENCES IN HYDRAULICS.

The question of wheel regulation at once constitutes the most serious encountered in the whole installation and the method now being tried consists in tapping the main pipe

FIGURE 7—POWER HOUSE OF THE SAN JOAQUIN ELECTRIC COMPANY, SHOWING RECEIVER AND MODE OF WITHSTANDING THE END THRUST OF THE PIPE LINE.

under the concrete and into the seams of the bedrock, coming out in the power house and outside of it. To obviate this a 14-inch steel pipe, 4 feet in length and having a heavy steel plate across the lower end, was let into the bottom of the wheel pit in line with the jet, the idea being that the pipe would fill with water and form a water cushion to take up the blow. Instead of doing this, however, it merely reversed the direction of the stream, and the waste water landed on top of the power house, not taking the usual course. Then some one recommended that the wheel pit be dammed up so as to carry two or three feet of water, which would tend to prevent the emptying of the cushion pipe, with the only difference from the preceding experiment being that in addition to the waste water the water impounded in the wheel pit was also landed on the station roof and thereabout. Nevertheless the "water cushion" pipe was allowed to remain, but it was filled level full with concrete and the bottom was completely floored over with 3-inch planking which was sheathed for

line at a point sufficient to give a head of 200 pounds at the power house. At this point an auxiliary tank with an independent six-inch pipe is to be erected, and from the constant, or unvarying water pressure thus realized, the constant speed Pelton wheels for operating the governers will be driven. In addition to the Pelton differential deflecting nozzle governer, other governers are to be tried, among which will be the Lighthipe electric governor, soon to be described in these columns. The weight of the water contained in the pipe is approximately 317 tons. The end thrust thrown upon the receiver is about 93 tons, to withstand which four 2½-inch stay bolts solidly bolted to the receiver have been imbedded in beveled abutments, as shown in Figure 7. The receiver itself is 57 feet in length, with a diameter of 30 inches; it is constructed of ¾-inch flange steel, with a tensile strength of 60,000 pounds and an elastic limit of 30,000 pounds. External and internal butt straps are placed thereon in five-foot courses. It is riveted throughout with 1-inch rivets and

the stay bolts for withstanding the end thrust are welded to ¾-inch boiler plates, 10 inches in width, that are in turn riveted to the shell of the receiver. The receiver carries two relief valves, and all mountings are of phosphor-bronze, the nozzle saddles being of cast steel. Before leaving the Risdon Iron Works, where it was built, the receiver was tested to 800 pounds hydraulic pressure, which was considered noteworthy; but since its installation it has been subjected to a far greater strain without injury, as will appear shortly.

It did not take long after water had been run into the pipe to demonstrate that while water at a head of from five to six hundred feet may be considered a liquid, yet at a head of 1,400 feet it becomes a solid with the strength of the hardest steel. The gates and relief valves ordinarily used were placed upon the equipment. The relief valves in particular had, up to that time, been considered perfection, and the balanced internal pressures were so thoroughly worked out as led to the belief that they would operate satisfactorily under any pressure, but the vital point of the friction which ensues from the contact of metal with metal when under high pressure was under estimated, and as a consequence the relief valves are practically inoperative. It is the belief of the engineer in charge that at high pressures water must be relieved by something cumulative. The use of compressed air is impracticable, because of the fact that the air will be forced into the water and the practice finally adopted for protecting the equipment from water hammer, consists in the adoption of gates for controlling the rate of opening and closing, rather than in the use of relief valves.

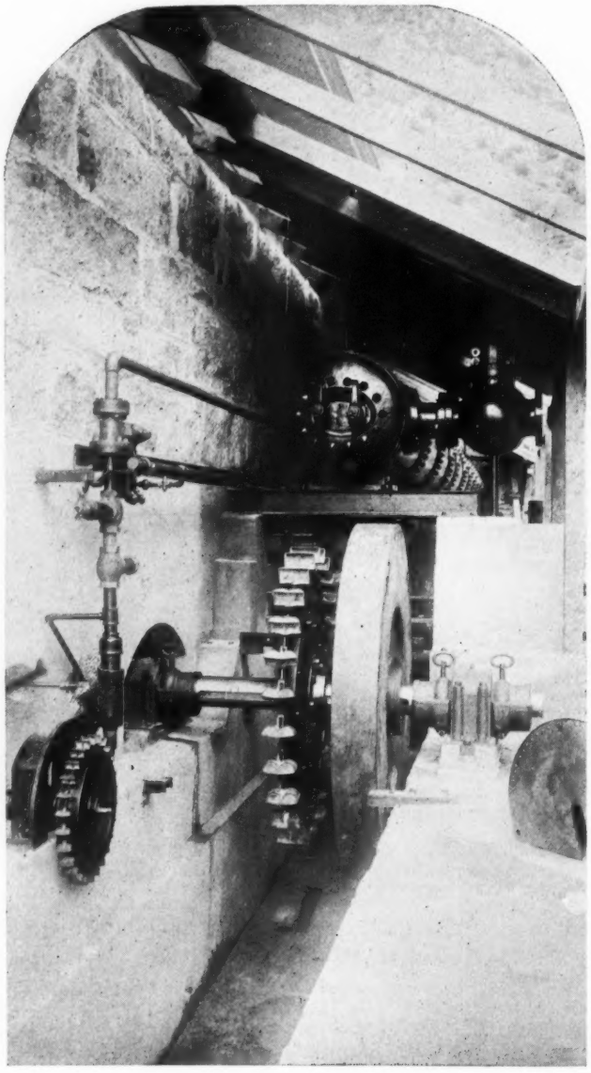


FIGURE 8—PELTON WATER WHEEL MOUNTINGS, SHOWING FLY WHEEL, EXCITER WHEEL AND LOWER END OF THE RECEIVER.

At the power house the gates are controlled by hydraulic rams actuated by water taken from the pipe line. As originally installed, any one of these rams opened the gate so as to cause a fluctuation of 170 pounds from the normal, and here is noted a phenemena due to the elasticity of the pipe. With the original equipment upon opening the gate the pressure would drop 90 pounds below normal, then rise to about 80 pounds above normal; then drop in wave motion to say 75 pounds below normal and so continue for from 20 to 30 seconds, until the normal pressure was reached. Upon closing the gates precisely the same conditions would arise with the exception that the initial change would be 90 pounds above normal. The acts of opening or closing the gates are therefore identical, so far as water shock is concerned and so perceptible is this fluctation or "breathing" of the pipe, in the first or wrought steel section of the pipe line, that upon sitting astride of it one can feel its "breathing" as though it were a giant reptile.

The fluctuation of 170 pounds was altogether too great to admit of satisfactory operation and accordingly it was determined to reduce the speed of the ram in opening or closing the gates by reducing the size of the exhaust outlets in front of the piston. Accordingly the diameter of these orifices (one at each end) were reduced to ⅛ of an inch each, which reduced the water shock to 50 pounds above and below normal. But 3-32-inch orifices were eventually adopted which increased the time of opening or closing the gates to 30 seconds and reduced the water shock to 30 pounds above and below normal. These devices were entirely automatic in their action, giving absolute satisfaction in the handling of the head.

The experience with this pipe line has, as stated, made it plain that when water is under high pressure in a large column it becomes the equivalent of a solid bar of equal weight, standing on end, and it is from handling this column of water, 4,000 feet in length, weighing 317 tons and exerting a pressure of 609 pounds, that the conclusion is reached that this column of water must be handled in exactly a similar manner as would be devised for handling

a solid column of like dimensions, namely: time must be an element in starting and stopping the column in order to overcome the "Water shock," or combined force of the momentum force of the water itself, and the expansion and contraction of the containing vessel. With this idea of "time," as a simple thought, the volume should be set in motion and brought to rest by a device that would be the equivalent of withdrawing an inclined plane, the taper of which is represented in the time required in getting the column in motion, or in other words, to handle water successfully under extremely high heads there is only one true and safe way, and that is by means of screw gates, as by this means the column of water can only be started or stopped very slowly. If this method is employed water shock and at the same time relief valves for taking care of the same, will be an unnecessary problem.

Under the head of relief valves for very high pressures the conclusion reached is that any method whereby water is discharged is more liable to constant increase of water shock than otherwise, as it has a tendency to increase the velocity of the water column, which in itself is the primary cause of water shock, and hence the conclusion is that devices for handling high heads should be so arranged as to make water shock absolutely impossible, however careless operatives may be.

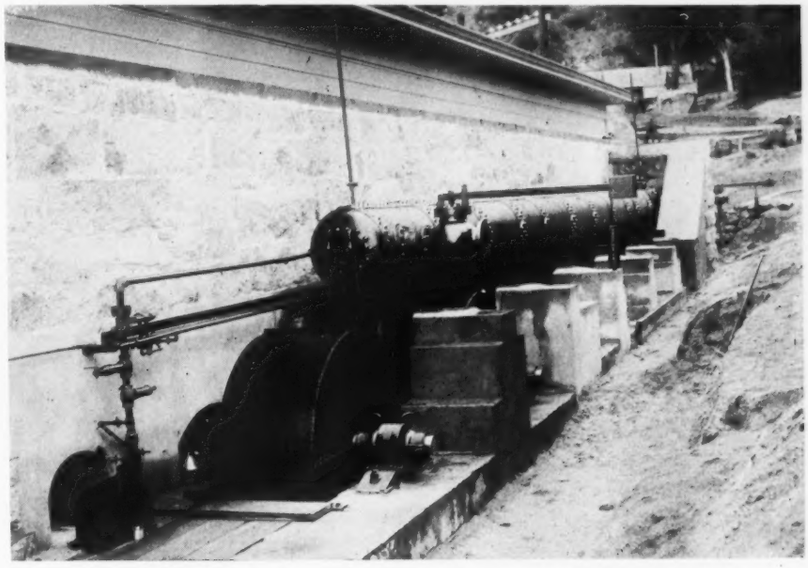


FIGURE 9—THE COMPLETED RECEIVER AND PELTON WATER WHEEL PLANT.

As shown in Figure 9 the receiver is mounted alongside the power house and directly beneath it are the Pelton water wheels constituting the power plant. Independent single jet Pelton wheels are furnished for each generator and exciter, and two smaller wheels operate a line shafting at constant speed for driving the governor mechanisms. In the main wheels the Pelton wheels have an outside diameter of 57 inches and each wheel carries 27 buckets bolted to its periphery. The speed is 600 revolutions per minute. On the same shaft with the main wheel is seen the 6000 pound fly wheel 60 inches in diameter with which each wheel is provided. On the periphery of the fly wheel is shrunk a heavy cast steel band two inches thick to prevent its disruption at high speed from centrifugal force. As the water wheel and generator outfit is direct connected and as the armature weighs about 7000 pounds, the total

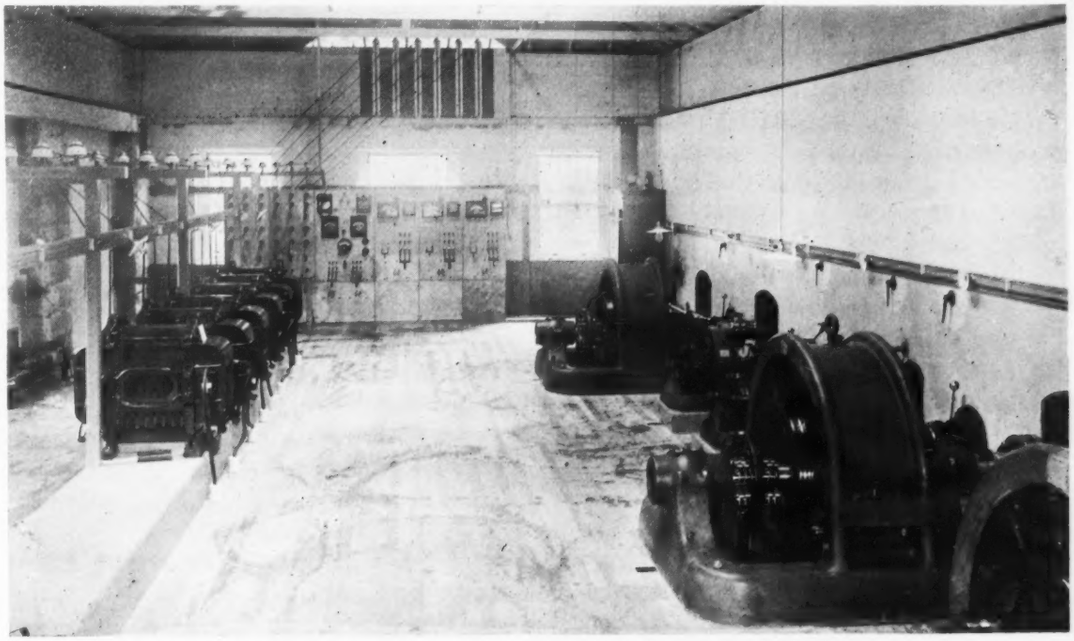
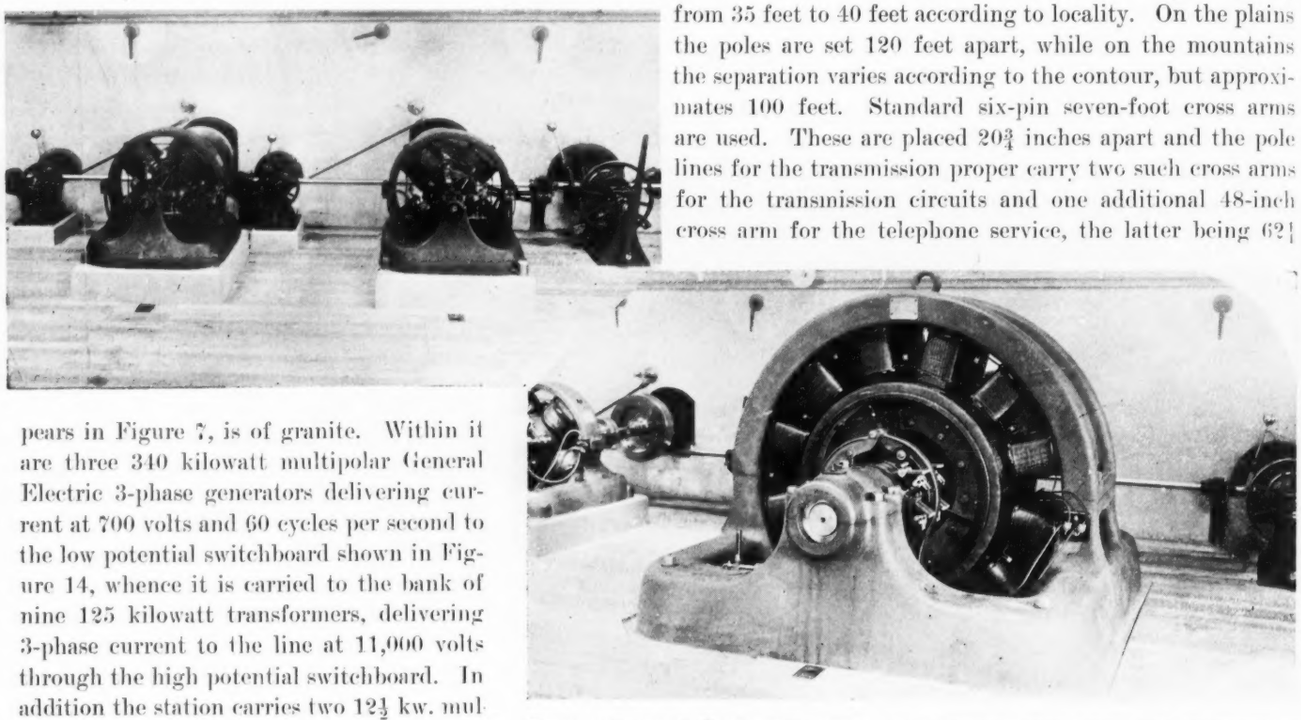


FIGURE 10—GENERAL VIEW OF THE INTERIOR OF THE POWER HOUSE.

mass available for fly wheel effects aggregates 13,000 pounds. The diverting nozzle mode of regulation is used but it is probable that the conditions prevailing will necessitate the devising of special regulating apparatus to meet the conditions imposed.

THE POWER HOUSE.

The power house is a model of central station architecture; it is 76 feet long by 36 feet in width, and as appears in Figure 7, is of granite. Within it are three 340 kilowatt multipolar General Electric 3-phase generators delivering current at 700 volts and 60 cycles per second to the low potential switchboard shown in Figure 14, whence it is carried to the bank of nine 125 kilowatt transformers, delivering 3-phase current to the line at 11,000 volts through the high potential switchboard. In addition the station carries two 12½ kw. multipolar exciters, each being of sufficient capacity for the operation of the entire plant. The method of high potential wiring used in the power house is shown in detail in Figure 13.



FIGURES 11 AND 12—SHOWING EXCITERS AND CONSTANT SPEED REGULATOR SHAFNING AND ONE OF THE 340 K. W. GENERATORS, RESPECTIVELY.

The power house and sub-station are protected by Bell lightning arresters and choke coils, the detail of which are best shown in Figure 18. Each transmission line upon entering the station is taken through a choke coil consisting of 150 feet of the same size of wire as used in the line. In the present instance, No. 3 B. & S. copper wire covered with weather proof insulation is coiled into a ring fifteen inches in diameter, the whole ring then being well taped. From the coil the high potential circuit is carried to the high potential switchboard and thence to the step-down transformers. At ordinary periodicities, such as 60 cycles per second as used in the Fresno plant, the self-induction of these rings is inappreciable, but at the enormous frequencies of a lightning stroke the coils prove effective in protecting the apparatus beyond them and in forcing the lightning to take the path to earth provided through the lightning arresters. Each of the transmission lines is provided with a lightning arrester as shown and these consist of 40 non-arcing metal cylinders screwed to a base and hence removable, the surface of each being separated 1-32 of an inch from that of the adjoining cylinder. The ground discharge from the bottom of the arrester is carried to earth by a copper ribbon one inch in width by 1-32 of an inch in thickness. Similar rings with suitable arresters are also placed on the 1000 and 2000-volt circuits extending from the sub-station.

THE POLE LINE.

The entire pole line, whether on the mountains or over plains is constructed of square sawed redwood poles, 12 by 12 at the butt and 6 by 6 at the top, the length varying from 35 feet to 40 feet according to locality. On the plains the poles are set 120 feet apart, while on the mountains the separation varies according to the contour, but approximates 100 feet. Standard six-pin seven-foot cross arms are used. These are placed 20¾ inches apart and the pole lines for the transmission proper carry two such cross arms for the transmission circuits and one additional 48-inch cross arm for the telephone service, the latter being 62½ inches below the lower high tension cross arm. Certain portions of the pole line are eqipped with a third cross arm for carrying the vineyard circuits of the company.

The poles were hauled and erected by the San Joaquin Electric Co. and the task was beset with difficulties owing to the mountainous country and the frequent blasting necessary in digging holes. Throughout the timbered portions of the route a 20-foot clearance has been cut, as have all trees that could by any possibility fall across the circuit. In addition to this clearing the San Joaquin Company constructed a wagon road 4½ miles long and a bridge having a 100 foot span and 340 feet of approaches.

The transmission circuits consist of two 3-phase 3-wire sets which may be used independently or together as desired. All wires are of No. 3, B. & S. soft-drawn copper. These two sets are divided by the pole, and the top cross arm supports two wires of each set, the third wire being immediately below. The lines are arranged so as to form an equilateral triangle having twenty-four inches on a side and the main line is transposed every 40 poles, or approximately every mile. Standard triple petticoat porcelain insulators are used and the method of tying is peculiar. A No. 8 soft copper tie wire is used. This is about 20 inches in length and in placing the line wire in the top groove

the tie wire is placed with it and its ends are carried around the insulator groove in the same direction, each end making a complete circle before being wrapped. The wires were strung by a line corps of the General Electric Company, under Mr. B. O. Boswell, Superintendent of Line Construction, and although the line construction did not begin until January 13th last, it was finished on February 23d, twenty-three men being employed in the work. Only one trouble has yet occurred to the line and that was due to a defective insulator which caused a short circuit equivalent to a load of 6000 lamps at Fresno. The circuit was at once cut out, the entire load was thrown upon the other set of lines until the following morning, when the trouble was found and remedied.

The results obtained from the telephone circuit carried over this pole line are truly marvelous. Hunning's dust transmitters of a type that do not infringe the patents of the American Bell Telephone Company are used over a circuit of No. 14 hard drawn copper wire supported by porcelain knobs. The telephone circuit is transposed at every fifth pole through the use of Locke's transposition insulator, and the line is absolutely quiet despite the facts that its length is 34½ miles and that the initial potential is 11,000 volts.

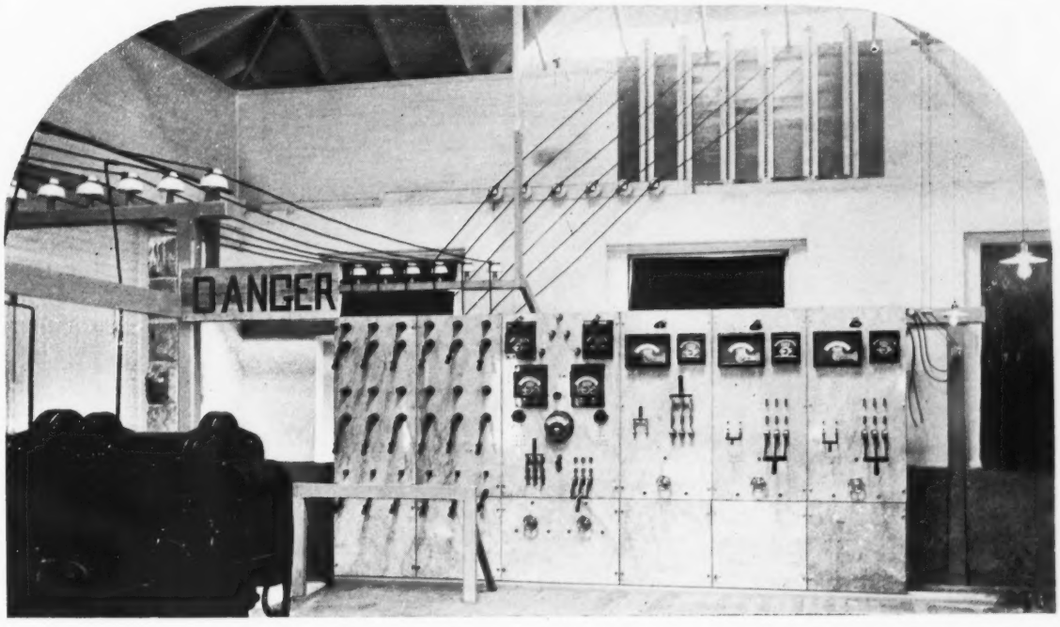


FIGURE 13—GENERATOR AND HIGH POTENTIAL SWITCHBOARDS AT THE POWER HOUSE, SHOWING METHOD OF HIGH POTENTIAL WIRING AND LIGHTNING ARRESTERS.

THE SUB-STATION.

The transmission lines enter the sub-station in Fresno in the manner clearly shown in Figure 18. The high potential switchboard there shown is not accessible and the switches are thrown by the use of a long bamboo pole with a ring on the end. It is difficult to measure the length of the arc drawn out on throwing the switches because of irradiation, but even at full load it does not appear to be in excess of one-half of an inch. The high potential switchboard affords the means for throwing any of the various types of step-down transformers on to either one or both of the two sets of transmission lines. These step-down transformers are all of the air-blast type and are divided into three sets, each designed for a separate purpose. Three 125 k. w. transformers with secondaries wound "Y" deliver current at 115 volts to the 4-wire commercial incandescent circuits. The second set consisting of three 75 kilowatt transformers with secondaries wound "delta," deliver current at 1000 volts for operating power circuits through the use of induction motors. The third set, consisting of three 40 kilowatt transformers, also wound "delta," delivers current at 3000 volts for the vineyard and other outlying districts. A 5 kilowatt induction motor drives a Sturtevant blower for the cooling of the transformers and the fact that this motor is belted to the blower forms the only inharmonious feature in the equipment of the sub-station.

From these transormers the current is carried to the low potential board which is not fully completed at the present time. This board was designed by Mr. Ernest I. Dyer of the General Electric Company and consists of ten panels all but one of which are now in operation. Of these, five are for controlling the low potential incandescent service; one panel controls the 3000-volt vineyard circuit; one controls the Chinatown 1000-volt incandescent service; two panels control the 1000-volt mains for the outlying residence lighting; and the last panel controls the induction motors driving the Brush arc light machines shown in Figure 19. Each of these arc lighting sets consists of a three-phase induction motor direct coupled to an 80 lamp, 2000 candle power, Brush arc lighting dynamo, run at 700 revolu-

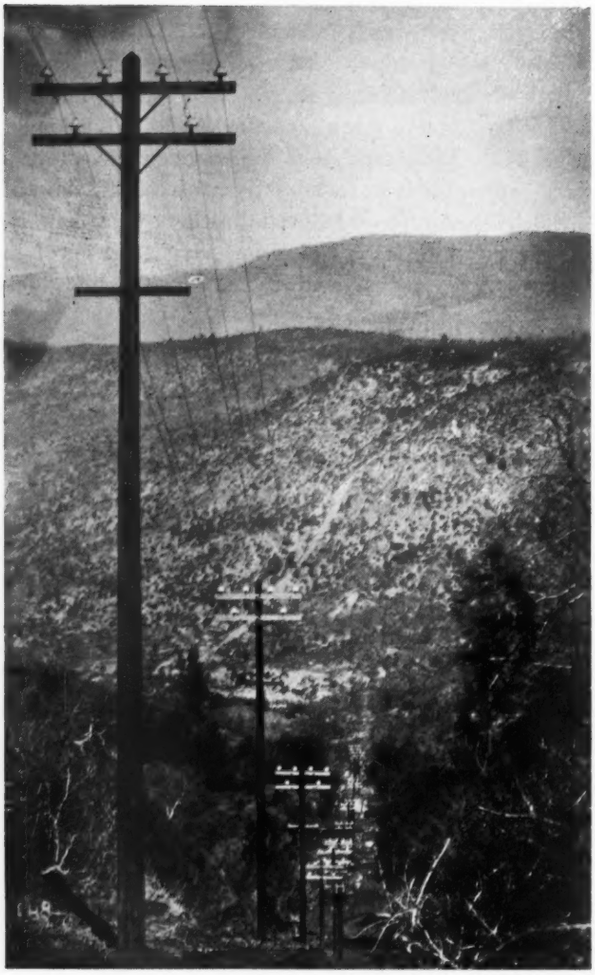


FIGURE 14—A PORTION OF THE MOUNTAIN POLE LINE, WITH THE POWER HOUSE SITE, PIPE LINE AND RESERVOIR MOUNTAIN IN THE BACKGROUND.

tions per minute. A special switchboard for the arc lighting service and which is not shown in the illustrations is of one panel carrying six circuits and provided with two Weston ammeters and four type "A" Thomson-Houston lightning arresters, together with the usual accompaniment of spring jacks and the differential equipment of the new regulator for Brush "Z" type dynamos. The 1000-volt power service is taken direct from the transformer to the line and the Chinatown service is rendered through a special 3000-volt transmission to Chinatown, where step-down transformers reduce the potential to 115 volts for distribution on the four-wire system.

The entire business section of the town has been wired up uniformly with the four-wire system. No. 0000 B. & S. bare copper wires are used almost exclusively as feeders and are so arranged that wires to the south and west of pole lines are the neutral wires and those adjacent thereto are the "A," "B," "C" wires respectively in the order of their sequence. This arrangement is due to Mr. J. N. Smith, Chief Electrician of the San Joaquin Electric Company.

The regulation of all circuits, whether for power or incandescent service is effected through potential regulators introduced into each outgoing circuit and by means of which the voltage is regulated at centers of distribution.

RATES OF SERVICE.

A surprising feature in connection with the San Joaquin Electric Company is the remarkably low rate at which electric service is rendered. The company has secured the municipal lighting contract for lighting the city of Fresno with 2000 c. p. arc lamps at the rate of $6.45 per lamp per month, all night and every night. Electric power is delivered approximately at the rate of $64.00 per h. p. per year 24-hour service, and incandescent service is rendered by meter rates or flat rates. The rate for meter service is 15 cents per kilowatt per hour, with discounts varying from 5 per cent to 25 per cent, according to consumption. In residence lighting flat rates prevail exclusively and the novel system has been inaugurated of charging for service according to the location of the lamp at the following rates per month:

Sitting room, 30 cents per 16 c. p. lamp per month.

Halls, dining room, or kitchens, 25 cents per 16 c. p. lamp per month.

Parlors, pantries, and barns, 15 cents per lamp per month.

Bed and bath rooms, cellar, garret, 10 cents per lamp per month.

FIGURE 15—VIEW OF THE POLE LINE NEAR FRESNO CITY.

The very favorable rates which have been established by the San Joaquin Electric Company for power service have already brought it several large contracts, principally among which is that of the Sperry Flour Mills, which is being operated by a 150 kilowatt synchronous motor running at 600 revolutions per minute. The city water works will also be run by electric power and a 75 kilowatt induction motor belted to a Root rotary pump having a capacity of 3,000,000 gallons daily has been installed. This latter equipment will displace a 4,000,000 gallon triple expansion Holly steam pump now used. At the present time the company is burning about 1600 incandescent lamps and has contracts secured for 1100 additional lamps. It is also prepared to enter upon its street lighting contract as soon as its pole lines have been completed, and is ready to deliver power as fast as motors are received.

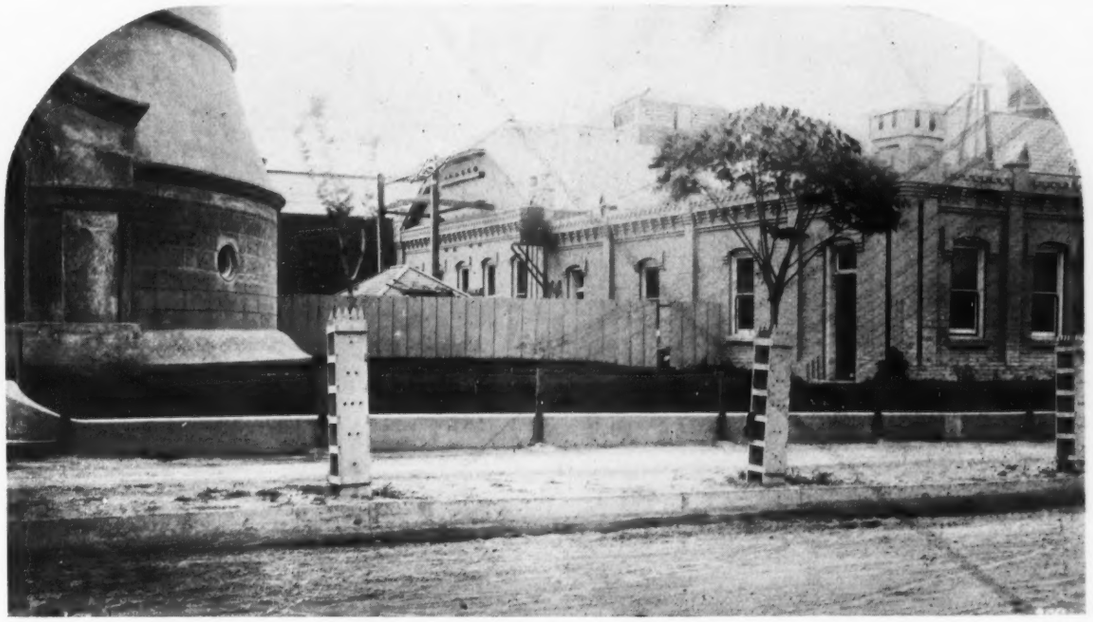


FIGURE 16—REAR VIEW OF THE SUB-STATION IN FRESNO, SHOWING MODE OF ENTERING HIGH POTENTIAL CIRCUITS.

PROMOTERS OF THE ENTERPRISE.

The conception of the plant of the San Joaquin Electric Company is due to Mr. J. S. Eastwood, a Civil Engineer of Fresno, who from his familiarity with the mountainous regions in the Sierras, back of Fresno, had long been impressed with the magnitude of the water power there available, and as soon as the feasibility of electric transmission over long distances had been commercially assured, he began the organization of a company for the purpose of developing water power and transmitting its energy to Fresno. Fresno offered a particularly favorable field for the introduction of electric light and power, because of the high price of fuel and the fact that the influences of the lighting interests theretofore existing had been bent in the direction of restricting the means of lighting to the use of gas and arc lamps. As a result of Mr. Eastwood's efforts, Mr. J. J. Seymour, President of the Fresno Water Company, became interested in the enterprise and they soon organized the San Joaquin Electric Company. This was accomplished on April 2nd, 1895, since which date the scheme has been perfected and the plant is now practically completed. It would be difficult to find a proposition of such magnitude that has been handled with greater celerity, and the installation stands a fitting monument to the genius and energy of California promoters. While the business detail has been handled mainly by Mr. Seymour, as President and Manager Mr. Eastwood has had charge of all engineering and superintendence, and his ideas are impressed so thoroughly throughout the various branches of the work that he can not but have won for himself lasting fame in the development and control of high heads of water.

The electrical apparatus used throughout is the three-phase type of the General Electric Company, and the entire installation was placed under the supervision of Mr. J. A. Lighthipe, Chief Engineer of the Pacific Coast office of the General Electric Company, and who was assisted by Mr. C. O. Schaefer, Superintendent of Construction of the sub-station; Mr. A. C. Jewett, Superintendent of Construction of the power house, and Mr. B. O. Boswell, Superintendent of Line Construction.

This describes the electric transmission plant which exceeds all others in the world in the combined points of size of plant, distance of transmission, and height of head of water used. It has an unfailing supply of 50,000 h. p. of water available.

Electro-Therapeuty

THE SCIENTIFIC APPLICATION OF ELECTRICITY IN MEDICINE—II.

BY W. N. WILLIAMS, M. D.

In reference to the human body as a conductor of electricity, it may be interesting to state that the resistance from hand to hand is from 2000 to 5000 ohms, which is more than twice the resistance of the Atlantic cable. A battery of five primary zinc carbon elements, equal to 10 volts, in passing through 2000 ohms, gives five milliamperes, which would be a result difficult to attain under ordinary circumstances.

For various reasons the Faradic or induced current is not so often indicated or applied in electro-therapeutics as the galvanic current. As yet there is no scientific means of determining its physiological efficiency or its therapeutic measurement, hence it has made but little progress as compared with other currents during the past twenty years. Among the specialists, there is a tendency to favor those instruments giving varying resistances and electro-motive forces from different lengths and thicknesses of wire. A standard instrument much used at present is the Dubois-Reymond coil, which is so arranged that the sec-

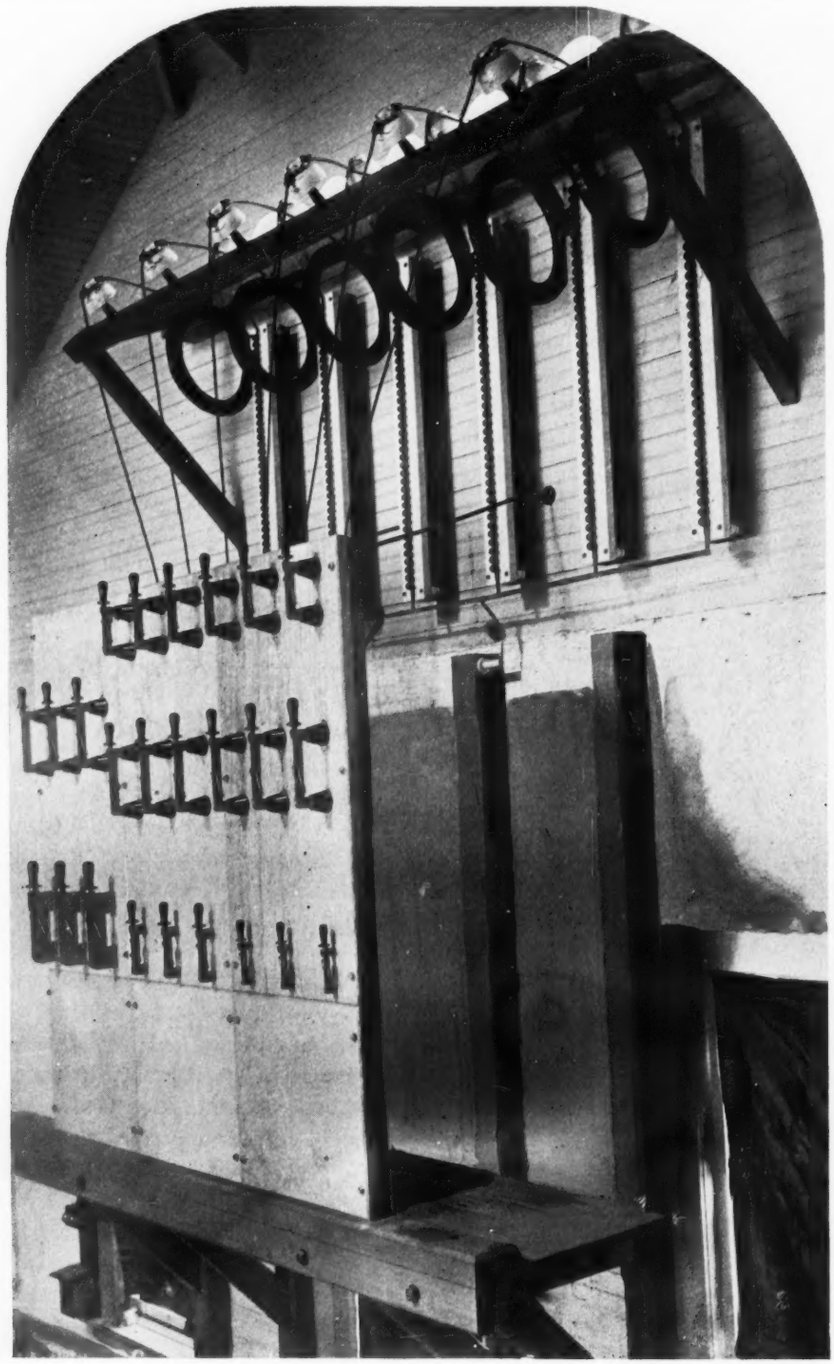


FIGURE 17—HIGH POTENTIAL SWITCHBOARD AT SUB-STATION, SHOWING LIGHTNING ARRESTERS AND CHOKE COILS.

ondary slides over the primary coil, by means of a rack and pinion adjustment. The therapeutic effect of the secondary coil, which is of long fine wire, is sedative and pain-relieving, and many of the coils now made have secondary coils, of fine wire wound in various lengths, but such coils, however, are not in general use.

The various electrodes for applying the Faradic current have changed but little from the older forms. Electrical massage has become a useful and effective means for treating some forms of nervous disease. Faradism is used in this treatment and is applied by placing one electrode in a fixed position, the other electrode being the hand of the operator, passed over the skin and muscles of the patient, thus applying the electricity and massage with the same hand. The dry cell

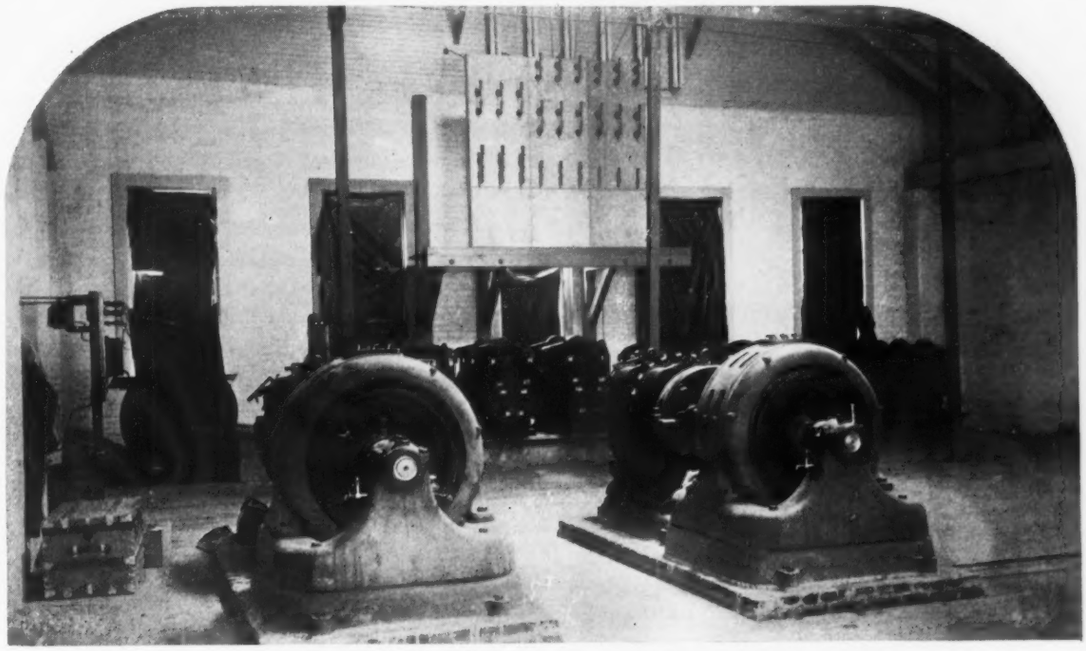


FIGURE 18—AN INTERIOR VIEW OF THE SUB-STATION, SHOWING HIGH POTENTIAL SWITCHBOARD, STEP-DOWN TRANSFORMERS, BLOWERS, INDUCTION MOTORS AND ARC DYNAMOS.

Faradic batteries are largely replacing the old style of fluid cell battery—and where a portable battery is required they are far superior in every respect. Many styles of the dry Faradic battery are made so small and compact that they may be easily transported in the physician's overcoat pocket, or in his hand satchel with other instruments.

With specialists, the tendency seems to be in favor of the new sinusoidal machine as a substitute for the Faradic coils. Dr. Aposoli, the great French electrotherapeutist, was among the first to recognize the superiority of this current for medical purposes over that of the secondary current of the Faradic coil.

Prof. A. E. Kennelly has produced and placed upon the market a machine for producing this current. It runs very smoothly and produces a current of a most pleasing character, with an entire absence of that pricking, painful sensation characteristic of the secondary current from Faradic coils. In the Kennelly sinusoidal machine, therefore, there is an entire absence of this painful, jerky, interrupted current. As there is no interruption in the circuit, it is a simple, harmonic wave, undulating equally above and below the line of zero potential, hence the sensations produced in the Kennelly machine instrument are soft, agreeable and equally developed at either pole, and patients who will not endure the weakest current from a secondary Faradic coil, will cheerfully submit to an application of this sinusoidal current.

The construction of the Kennelly machine is on scientific principles. The field frame is of laminated iron, supported by twelve castings, and has twelve poles. On each pole is a spool with two series windings of wire, the secondary or inner winding having eight layers of fine wire, and the outer or primary winding having two layers of coarse wire. By this arrangement the armature, when driven, transforms the continuous primary current into alternating current waves in the secondary circuit and by the arrangement of the armature surface these waves are made sinusoidal.

For every revolution of the armature twelve complete periods are generated, and with a maximum speed of 4,800 revolutions per minute the frequency may be carried to 1920 alternations per second. The alternator is arranged to be driven by a motor on a 120-volt circuit, and the primary winding is excited by the same, controlled by a lamp rheostat, thus affording independent graduation of frequency in the secondary currents. This current has been very successfully used by Dr. Apostoli of Paris.

Professor d'Arsonval first discovered the powerful action of this current on all living bodies submitted to this inductive influence. The best method of applying it is to place the patient, free from all contact with electrodes, in the circuit of a larger solenoid traversed by these currents. The patient being thus completely insulated, the currents which circulate in his body by auto-condition have their origin in his tissues, the body playing the role of a closed induced circuit. By these methods the physiological discoveries of d'Arsonval are verified, and we are able to prove the powerful influence of these currents upon the vaso-motor system. Although they produce no sensation and have no apparent effect on the motor or sensory nerves they are found to exert a powerful action on all the nutritive functions.

THE JOURNAL OF ELECTRICITY.

An Illustrated Review of the Industrial Applications of Electricity, Gas and Power.

EDITED BY

F. A. C. PERRINE, D. Sc., and GEORGE P. LOW.

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EDITORIAL.

ECONOMIES IN COAL CONSUMPTION

The central stations belonging to electric lighting plants and street railroad companies upon the Pacific coast are so large and well built that one should perhaps hesitate before criticising in any particular their methods in handling fuel or generating steam. Much capital has been expended upon water cooling plants for condensers and the subject of steam economisers has been so carefully worked out by our central station engineers that one would not expect to find any question concerning the use and quality of coal neglected in station construction. At the same time an examination of many of the large central station plants situated upon the coast, will disclose the fact that they are generally employing expensive Welsh coal to the almost entire exclusion of the cheaper fuels which may be obtained nearer home. It is true that the coals used are the highest in calorific power to be found in the coal mines of the world, but at the same time it is equally true that the expense of these coals per calorie is greater than that of the inferior native products, the reason of their choice being that with the existing furnaces the production of steam is less expensive with the more costly coal.

While this fact reflects credit upon the engineers who have charge of the existing plants, at the same time it is not equally to the credit of those who were called upon to design the plants or upon those who may modify these plants after they have been designed. The construction of a furnace necessary to burn anthracite coal is undoubtedly less expensive than the construction necessary for an equally high efficiency in the combustion of cheaper grades of coal, and where the difference in price of the two coals does not warrant a great furnace expenditure, there is no doubt but that the coal of the highest calorific power is the cheapest from every consideration. This is the state of affairs both throughout the South of England and along the Atlantic seaboard, while the practice among central station managers along the Mississippi river has clearly indicated that within reasonable limits the cheapest coal is the cheapest steam producer, whenever the engineer of construction has carefully studied the low grade fuels available and has installed boiler furnaces adapted to their combustion with high economy.

The difference in price between high and low grade fuels is even larger upon the Pacific coast than it is along the Mississippi river, and yet Western engineers have not thoroughly attacked the problem of the economical combustion of low grade fuel. The newer power houses of the Market Street Railway Company in San Francisco have been equipped for the combustion of cheap coal and there is no doubt that such an equipment will prove its wisdom when the yearly coal bill has been considered. Through the influence of these plants, we may hope to see this subject carefully taken up by central station designers with the unquestionable effect of reducing the cost of energy delivered by the station. The present practice of buying coal by the amount of steam produced is one which tends to crystalize all the old errors that have been made in original furnace design, even if the method of thus paying for the coal supply is followed it is a better practice and better contracts should result from the careful overhauling of boiler furnaces and the construction of such furnaces as will allow the employment of the cheapest coals on the market at their highest efficiency.

COMBINATION FOR GENERAL GOOD

The recent announcement of consolidation between the electric and gas companies of San Francisco compels one to consider whether the general consequences of such movements act for the benefit of the customers, as well as for the stockholders. The term "combination" or "trust" has come to mean much oppression throughout the country on account of the fact that many large organizations have endeavored to use their power in a manner which is oppressive to their patrons. Such action has often been required by the excessive capitalisation of the concerns entering into combinations, as well as on account of the fact that these combinations are at once plunged into both ruinous competition and unwarranted litigation, brought about by the odium attached to the name of "combination." It is obvious to any one who has considered the lighting situation in a large city that more advantages are to be gained from a great combination than from excessive over-competition, since consolidated companies stand toward the public in the light of a municipal corporation, while their private management guarantees an operation far more economical than can be obtained by any municipality.

It is impossible to say that any great company depending upon a city for its franchise can be divorced entirely from politics, so that in comparing it with the business

undertakings of a municipality we have in both cases political expense which in either case may or may not become an excessive burden. This political burden is, as we have already stated, very frequently the reason for excessive charges by a great corporation, and we believe that should the people of the cities devote the same attention to preventing the blackmailing of such business enterprises by the politicians as they at present devote to the private affairs of the corporation itself, the expense of the corporation would be so far reduced as to enable it to furnish power or gas at rates which would be below those possible with the two companies in competition, as well as at rates below any which the city could establish, should a municipal plant be installed. If politics could be eliminated altogether from the business management of the lighting industry, the consolidated company would depend upon its good behavior for patrons and non-interference in its business, and there is no doubt but that the ultimate effect of such consolidation would then be of unmixed benefit to its patrons.

TESTING UNDER GROUND CABLES

The quality of cables to be used in underground construction in high potential working has become a consideration of increasing importance since the large cities are demanding the condemnation of the overhead electric lines. In view of this fact it is important to obtain as much as can be had of the history of underground construction and as wide a knowledge as possible of the experiments that have been tried in cable manufacture. In this connection it is well to point out the action which is apparent in the breaking down of any electric cable by high potential current. With all cables insulated by the use of fibres or any diaelectric excepting the solid gums like gutta percha and vulcanized India rubber, there seems, upon experimentation, to be found what might be called a critical breaking down point which is dependent upon the character of the insulation but not upon it thickness. By this we mean that the saturated fibre insulated cable will fail under the application of a certain value of electro-motive force and an increase in the thickness beyond a certain limit will not appreciably increase the resisting power of this particular insulating material. This anomalous result may perhaps be explained by a reference to the experiments which have been performed upon cables insulated with paper, in which it has been found that the breaking down point is lower with dry paper insulation than with paper insulation which has been saturated in spite of a lower insulation resistance, and that the breaking down E. M. F. for a cable insulated with dry paper is approximately the same as the E. M. F. necessary to spark across the freshly cut end off a paper insulated cable, thus indicating that the breaking down of any cable takes place through the movements of electrified particles carrying a charge from the core to the cable sheath until finally charring takes place when conduction follows. Air bubbles, which are spaces containing rarified air within the insulation of the cable, are found also to have an important bearing upon this value which may be called the critical breaking down strength of the insulation. From these considerations a caution can be issued to all users of underground cable that their cables for high F. M. F's. should be chosen, not so much for the strength of the insulation resistance as shown by a galvanometer test, but by their physical characteristics of the dielectric and perfection of manufacture as may be indicated by high potential tests carried to the breaking down limit. The dry air paper insulated cable a few years ago obtaied many friends, and at the present time we find that it is reappearing in England, where the engineers will undoubtedly try their own experiments and will probably ultimately arrive at the same conclusions as have been arrivd at in this country, that the breaking down strength of paper cables unsaturated is less than that of the same cables saturated with any simple liquid dielectric. A little care and a little study of such problems will always guard against many errors that may be committed by those who are unwilling to examine carefully the history of the apparatus they are intending to use.

TRAFFICKING IN TRANSFERS

We called attention a few months ago in our columns of Passing Comment to the demoralizing effect of transfers on street railroads in increasing the opportunities of stealing by motormen and conductors, but we did not expect so soon to see the moral disadvantage of such a system exemplified in San Francisco and extended to the general public, but we are compelled to call attention to the shameful lack of moral sense possessed by the patrons of the roads in that city, and advocated by some of the more important newspapers. We refer to the practice of handing transfers to news boys, who use them as premiums in aid in the sale of their papers. Such practices are nothing more nor less than theft, and no matter how we may feel towards the monopoly which operates the railroad system, we cannot but see that such practices must have a demoralizing effect not only upon those who practice this system of stealing, but also upon the general public, when the newspapers are led by it to advocating the time honored principle that stealing from a corporation or from the Government is no crime.

Small straws show the direction of the wind, and the public sentiment which will accept such principles from the daily papers is surely to blame for thefts in municipal management as clearly as are the corrupt officials themselves. The convenience of a transfer to the traveling public and the premium which they put upon riding should be sufficiently well understood by the railroad management, but at the same time much remains to be hoped for in this system until the element of dishonesty has been eliminated altogether from its use.

Passing Comment

AN EDITORIAL REVIEW OF CURRENT EVENTS AND PUBLICATIONS OF OUR CONTEMPORARIES.

THE SPECTACULAR IN ELECTRICAL ENGINEERING.

The managers of the Electrical Exhibition in New York are striving after spectacular effects and have developed two of the most striking plans that have heretofore been seen and yet perhaps the most remarkable thing concerning these exhibits is that they will not occur to electricians as being in any way noteworthy or the results problematical. These achievements merely mark the thorough management of great electric corporations, rather than remarkable effects of electrical engineering. The first of these results was the opening of the exposition itself, as performed by an electric signal sent from New York to San Francisco, and thence back to the exhibition building, where a relay was operated and the machinery of the exposition started. The second startling result obtained is the operation of a small model of the Niagara power plant by an electric motor driven from the generators established at the Falls. A further employment has been made of the current so transmitted across the State of New York to send messages from the exposition building through the cables to Europe, thus completing the transmission of Niagara power, not simply across the State of New York, but across the Atlantic Ocean as well. Of course, no effort will be made in this experiment to produce an economical transmission of power over so great a distance, but the fact that the transmission can be made shows that the science of electrical engineering has solved the long distance power transmission problem without reference to the distance and that the question of any transmission is one not of engineering, but of financial results.

"THE DOOM OF THE CABLE IN SAN FRANCISCO."

In the February number of the Street Railway Journal is a very significant article by S. L. Foster, entitled "The Doom of the Cable in San Francisco." It has been many times stated and as often denied that there was an intention on the part of the management to replace all of the San Francisco cable lines with electrical construction and the people have fancied to read in such a change some infringement of their rights. Since every touch of this idea must be avoided by the street car company, it has persistently denied the existence of an intention to alter its locomotive system. Apparently, however, from this article, it has at last determined to announce its intention of gradually changing its entire system to electric haulage and we should consider the consequent effect upon the city and its traffic.

The experience of other American cities has proven that the service given by electric roads is generally preferred to that given by cable roads, with the exception of those in New York and Chicago, where particular conditions render the cable roads acceptable. In New York the traffic is from North to South through the axis of the island. New Yorkers are unused to transfers and do not demand transportation off the line of the main railroad. In Chicago the cable roads connect densely populated suburbs with the business portion of the city, these suburbs lying in three different directions, north, south and west; but if now we refer to the cases of Boston and Philadelphia, we will find cities in which the direction from the business section to the residences of business men is indefinite, and in consequence it is necessary for the tram lines to give equal transportation facilities to many points radiating from the business center, which can be done only by the means of electric traction. Very much the same case is found in San Francisco, and as the city gows, new demands will be made on the railroad company for transportation which will require extra line construction in advance of increased traffic. By furnishing more cable roads the company would be required to operate many suburban lines at ruinous expense, and the public would be called on even more often than at present to exchange from car to car, thus increasing the already intolerable transfer nuisance. On the other hand, with electric traction, it would be an easy matter to send out cars from the business section to any one of many suburban points without materially increasing the operating expenses and at the same time reducing the annoying necessity of frequent changes from car to car. The attitude of the daily press has made the public at present unduly suspicious of any move made by the Market Street Railway Company, but we believe that the near future will demonstrate that the change from the cable to electricity has been made by the company as much for the convenience of its passengers as to increase its own revenue.

OVER ZEALOUSNESS.

An incident illustrating the inconsistency sometimes appearing in editorial utterances is found in a recent number of a lyocal electrical contemporary, which in discussing high potential switchboards, states that "the Folsom-Sacramento transmission plant was stopped for four hours recently by damage done to the high potential switchboard by lightning. It was due to the failure on the part of the contractor to have the lightning arresters put in. They should have been in place when the plant was first started up." Then the succeeding paragraph observes that the amount of power required for operating hoists in mines is an important consideration, and that inoperative hoists result from the tendency of mining superintendents to underestimate the power actually consumed. The local contemporary continues: "This old story has again been repeated in the history of the plant just started in Sonora county, for supplying power to the Rawhide Mine. The company furnished the machinery called for, but the mine superintendent had under-estimated the power required to operate the hoist and trouble followed. If a consulting electrical engineer had been employed at the start there would have been no trouble."

The suggestion may be in order that in view of the fact that the Folsom-Sacramento transmission was placed under the direction of a San Francisco firm of consulting electrical engineers whose abilities are understood by engineers in California, if not in the East, it would be well to at least place such discordant observations in different portions of the paper that the sensibilities of the parties concerned may not be offended.

Literature.

CATALOGUE OF BOOKS ON ELECTRICITY, ELECTRIC LIGHT, THE TELEPHONE, ETC.—For sale by D. Van Nostrand & Co., 23 Murray Street, New York. Distribution gratuitous.

We have just received the revision of D. Van Nostrand & Co.'s Catalogue of electrical books bearing the date of April 1896, which presents some distinct features as a book catalogue, and on account of arrangement into subjects forms a work of particular interest and importance. This company was the first one in America to issue a complete catalogue of electric literature, and at the present time its catalogue is the most complete published by any bookseller. In the present edition they have abandoned the old arrangement of an alphabetical list in favor of an author-catalogue subdivided into sections according to a very satisfactory subject classification which makes the catalogue at once valuable in studying a given subject, and renders the book easier to refer to in case any particular investigation is undertaken. Glancing over this catalogue, one is also struck by the fact that within the last two or three years many works have been published giving systematic treatment of the various problems in electrical engineering which have heretofore only been presented in a fragmentary manner, without true reference to actual practice.

THE DYNAMO, by S. R. Bottone. Ninth edition. New York: Macmillan & Co.; 116 pages. Price 90 cents.

We could have no better proof of the interest taken by amateurs in the manufacturers of experimental dynamos, than the continued success of this little book, which has carried it through nine editions since the first publication in 1887. The manner of treatment adopted by the author is one calculated not solely to enable an amateur to manufacture a small generator, but to lead him to the study of the principles underlying the action of such a machine. At this late day, however, we would expect to find enough experimental workers capable and willing to manufacture a more perfect dynamo to warrant the introduction of an appendix, showing the importance of making a laminated armature and describing the method of carrying this out, especially since the author has found it advisable to give methods of compound winding, as well as complete drum and ring aramture windings with many-part commutators. Such criticism, however, represents a wish for a more complete work, rather than a criticism of that which is done in this volume, where both the methods of construction and methods of study are well laid out and carefully described to such completeness that the merest novice will be able to follow the instructions and obtain a satisfactory machine capable of delivering a small current and to gain from the work an elementary knowledge of dynamo machine construction.

SYNOPSIS OF CURRENT LITERATURE DURING 1895. By Max Osterberg, E. E., A. M. New York: D. Van Nostrand, 1896, pp. 143. Price, $1.

The agitation for an index of periodical literature during the past few years which has been carried on by Mr. Fred DeLand in his publication "Electrical Literature," by Professor Sheperdson before the American Institute of Electrical Engineers and by many technical journals and technical societies throughout the country is bearing practical fruits in this volume extracted from the pages of "Electric Power" under the editorship of Mr. Osterberg, which has the great advantage over similar previous publications of being issued so early in the year following the publication of the articles indicated and for the reason, if for no other, will be found of great value to electrical engineers. In order to condense the extent of the work no attempt has been made at a complete index of all the articles indicated and for this reason, if for no but only those which seem of the greatest importance to the editor, which plan has the distinct advantage of bringing the publication within a reasonble limit of size and price and will in time make a series of such books so published from year to year immensely valuable. At the same time the selection made bears the distinct impress of the editor's mind, which is further impressed by the arrangement of the articles under the various headings employed; no other method perhaps is possible for publication in book form and the very limitation of the articles renders the classification employed easy to follow.

The ideal synopsis of technical literature will not be reached until such a synopsis can be published by each journal covering its own pages, arranged upon cards without headings that may be filed in the library catalogue of each subscriber to the journal according to the particular system of classification which the subscriber himself will choose. Until this system of indexing journals shall be adopted throughout technical literature we must rely upon some such a catalogue as that which we have before us. Typographically the synopsis of Mr. Osterberg is commendable for its clearness by which aid we may rapidly run over the headings in any section of the book without being confused with the digests of the articles themselves, though these digests are clearly enough printed to allow easy perusal and immediate reference to the original papers. Technical literature is often at fault in adopting ambiguous headings for the articles published, and here again we find that Mr. Osterberg's work is to be commended for the banishment of the titles printed in favor of short titles which are more descriptive of the articles themselves.

Certain phases of electrical engineering have unfortunately appealed but little to this editor and the articles which treat of these subjects have either been altogether omitted or included in departments where they must be rediscovered by those who intend to refer to them. The theories of currents and current measurements we find here well classified as are all articles relating to the manufacture of generating and transmitting machinery; particular processes such as metallurgy, electro-therapeutics and electro-chemistry are carefully indexed, but we fail to find any headings bearing directly upon line or circuit installation. The subjects of fixtures, subways, fuses, circuit breakers and other matters connected with them have been apparently entirely omitted, although as we all know important additions have been made to the literature of these subjects during the past year.

In conclusion, we must commend the admirable arrangement of the book in its indices and general system and we feel that we can assure the author that he has performed a work of great value which, as he no doubt feels, can be made complete only by an active co-operation of others who are capable to undertake a similar work in the lines which he has omitted.

Physics

THE DETERMINATION OF A LIGHT UNIT.

BY D. W. MURPHY

Within the past few years the determination of a light unit which should be suitable as a standard with which other light sources could be compared, has received no little attention in the scientific world. We are accustomed to define the amount of light given off by a source as being equal to that of some number of standard candles, by a standard candle meaning one that consumes a unit mass of wax, paraffine or other combustible substance in a unit of time. The amount of light from such a standard is necessarily a variable quantity, as it depends upon the purity of the substance consumed, and, as is the case with all flames, upon the meteorological conditions of the atmosphere. The former source of error can be reduced to a minimum

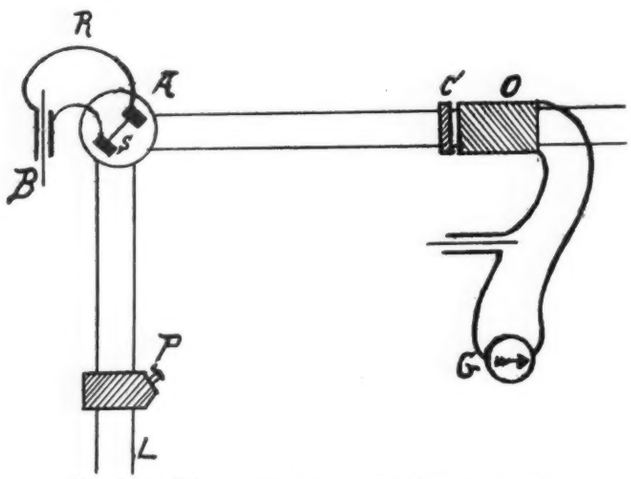

FIGURE 1—Scheme of the Lummer-Brodhum Photometer

by using a well-defined substance; and corrections based upon experimental data can be made for atmospherical changes, reducing the results to standard conditions. The final test, however, for such a unit as a standard, is whether in the hands of different observers concordant results can be attained. This has not been attained by any form of candle yet used. Measurements upon a paraffine candle in use for many years and adopted as a standard in Germany show that these variations were not less than 10 per cent.

The principal requirements of a light unit that will be serviceable as a standard are, first, that it shall be constant, and second, that it be simple enough in construction that it may be readily reproduced. The first requirement is one of a purely scientific nature, and may aid in the solution of the problem from a practical standpoint just in proportion as the second requirement can be realized. Since no standard yet prepared has given constant results in the hands of different observers, various attempts have been made to find some more reliable source with which comparisons can be made. To this end various light units have been proposed; among the most prominent of these should be mentioned the Heffner lamp and the pentane lamp of Vernon Harcourt. These are both open flame lamps, the substance used in the first being amyl acetate and in the second pentane. M. Viole has proposed as a unit the light emitted from a square centimeter of platinum at its temperature of volitization. This, while it would seem to promise good results, has not met with success in the hands of other observers. Another standard proposed independently by Professor S. P. Thompson and Mr. James Swineburn was to use the light given off from one square millimeter of the crater of the positive carbon in the electric arc lamp. None of these standards, however, together with the many more that have been proposed, have fulfilled the conditions required of a practical light unit. At the International Electrical Congress held in Chicago in 1893 attempts were made to bring about the adoption of a unit. Of those considered by the committee the Heffner and pentane lamp were the most promising. Objections were made to the Heffner lamp that the flame was too yellow in color, and to the pentane lamp that the commercial pentane is not sufficiently well defined. Finally the objection was made to all open flame lamps that they are too much affected by the temperature, pressure and moisture of the air.

The committee recommended that while its members realized the great progress made by the construction of these lamps, yet it was unable to recommend either as a light standard. If further invited all nations to make reseraches in common on practical, well defined standards, in the hopes of realizing an absolute unit. Since that time some further progress has been made and other forms of units have been proposed. The most of these, however, are mere proposals of what may be a constant source, but lacking careful experiments to recommend them to favor.

The following method of determining a light unit and the one which seems to promise best results so far attained has been used by Professor Lummer and Dr. Kurlbaum of the Physikalische Reichsawstalt. As a unit is used the light emitted from a square centimeter of platinum kept at a constant temperature. The platinum strip is heated by an electric current; the temperature is defined by the relation of the amounts of its radiations under different conditions. The one is the total radiation of the heated platinum, the other consists of the rays which pass through a definite absorption medium. So long as the ratio of these two remain the same the temperature of the source is constant. The amounts of these radiations are measured by means of the bolometer. The principles of this instrument, the use of which has been far reaching in physical investigations, were first worked out by Suanberg and later, but independent of him, by Langley.

The essential part of the instrument consists simply of a high resistance placed in an electric circuit; on this high resistance part of the circuit radiations are allowed to fall and the change in the resistance due to the temperature change measures the intensity of the radiations.

The apparatus used by Drs. Lummer and Kurlbaum consisted of a bolometer, with galvanometer and other

accessories for indicating changes in resistance, together with the light source, which consisted of a strip of platinum of approximately 25 millimeters wide, 60 millimeters long and 0.015 millimeters thick, so mounted that it formed part of an electric circuit. The platinum was heated to a high temperature by an electric current, whose strength could be regulated by a variable resistance. The light source was mounted on a form of optical bench, with two arms at right angles to each other. Upon the one arm the bolometer was mounted, and upon the other a photometer. By rotating the light source, which was at the junction of the two arms, on a vertical axis comparisons could be made either on the bolometer for the intensity of the radiations or on the photometer for the light intensity. The photometer used was of the Lummer-Brodhum type; the light with which the standard was compared was an incandescent lamp burning under a current of low intensity.

Previous results show that by burning a lamp in this manner its intensity could be kept constant for a very long period.

The general scheme of the apparatus is shown by Fig. 1. A is a circular plate of marble upon which the platinum strip, S, is mounted. A is so made that it turns about an axis passing through its center. The platinum, S, is connected with copper electrodes, which are connected with the battery, B. R is a variable resistance. On the one arm of the bench is the box, O, which contains the bolometer, which is connected on a battery circuit with the galvanometer, G. Between the light source and the bolometer is placed the absorption cell C. This cell is supported on a moveable screen so that it may be carried out of the path of the ray when it is desired to allow the entire radiation to fall upon the bolometer. On the other arm of the bench P and L represent respectively the photometer and the lamp against which the standard was compared.

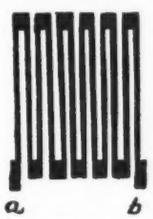

FIGURE 2

The bolometer was made in the following manner: A platinum plate is placed between two silver plates of some ten times its own thickness; the plates are then passed through rollers, the distance between which is constantly decreasing. As the silver plates become thin they are strengthened by being placed between copper plates and the rolling continued until the platinum is of the required thickness. In this manner a coherent piece of platinum as thin as 1-3,000 millimeters may be obtained. For practical working, however, a thickness of about three times this amount was more satisfactory. The thickness of those used in the experiment was 1-1,200 millimeters. When rolled to this thickness the silver adheres firmly to the platinum and serves as a vehicle for handling it in a manner that would be otherwise impossible. The silver sheet is then mounted on glass with Canada balsam and cut on the dividing engine in the form shown in Fig. 2. The twelve strips are each 1 millimeter wide, 1.25 millimeters apart and 3.2 centimeters long. The plate after being cut in this form is mounted on a frame of slate, the extremities being soldered to copper electrodes.

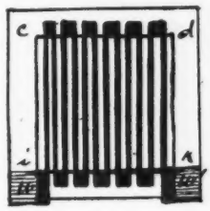

FIGURE 3

Fig. III shows the manner in which the mounting is done; c, d, k, i is the frame of slate, w and w' the copper electrodes to which the extremities of strips are soldered. After the mounting has been done the silver is removed by immersing in nitric acid.

The plate is removed from the glass by chloroform and fastened to the frame by means of resin dissolved in ether. To protect the extremities of the strips from the action of the acid they are covered with Japan varnish.

The surface of the platinum is blackened in order that it may absorb all rays received upon it. The blackening was done by means of platin black, thrown down by electrolysis, in a weak solution of platin chlorid and hydrochloric acid.

Two bolometers prepared as above described were placed one behind the other, so that the strips of one covered the spaces of the other, thus forming a nearly continuous surface on which the radiations were received.

The two pairs of bolometers were connected so that they formed the four arms of a Wheatstone bridge. The radiations fell upon the two opposite arms of the bridge.

The bolometers mounted in the form for the use are shown in Fig. 4. The two pairs are mounted in the hard rubber standards, h and h'. The radiations fell upon those in h. The openings, S, S' allow air to circulate freely through the apparatus. The plate g is of copper, blackened so that it will absorb all rays which fall upon it and serves as a screen to protect the bolometers mounted in h'.

The absorption cell consisted of a ring of glass with sides formed of parallel quartz plates. The quartz plates were 1 millimeter thick and 2 centimeters distant from each other. The cell was filled with pure water.

The temperature of the glowing platinum was so regulated that the total radiation which fell upon the bolometer was to that which passed through the absorption cell in the ratio of 10 to 1.

From a consideration of the curve of the intensity of radiations it is clear that this could be the case only when the temperature of the radiating source remained constant.

The amounts of the radiations were measured by the galvanometer deflections. Since it was impractical to work with deflections one of which was ten times as great as the other, the deflections were made equal. For this three different methods were used. The first was to shunt the galvanometer so that only 1-10 of the current passed through when the total radiations were received.

The second was by changing the resistances of the entire circuit so that their values were in the ratio of 10 to 1 for the total and partial radiations. This method was practi-

cal for relative, but not for absolute, measurements.

The third method consisted in changing the distances of the bolometer from the radiating source so that the distance for the total radiations was to that of the partial radiation in the ratio of the square root of 10 to 1.

At a fixed distance before the glowing platinum a diaphragm of exactly 1 square centimeter area was placed; the light which passed through this diaphragm was taken as the unit.

During the experiments the temperature of all parts of the apparatus, whose temperature change could affect the results, was kept constant by being enclosed in hollow-walled cases through which water was allowed to flow.

In order to reproduce this light unit it is necessary to measure accurately the size of the diaphragm and the thickness of the absorption cell, since these are the sources of error which most affect the results. Another but very small inaccuracy is introduced by a change in the thickness of the black on the bolometer. It was found that a change of 50 per cent in the thickness of this black gave a change of 2 per cent in the light unit. This, however, is small when we consider that the process of blacking is

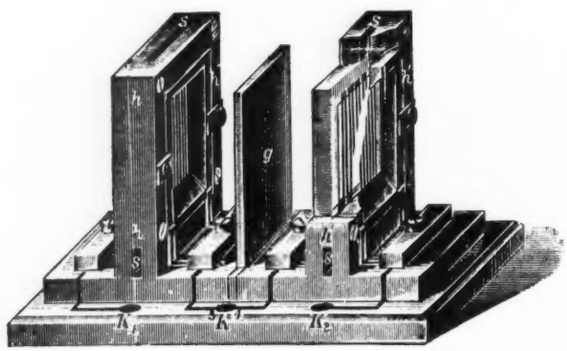

FIGURE 4—A Two-pair Set of Bolometers—From "Zeitschrift fur Instrumentenkunde," March, 1892.

based upon conditions quite readily reproduced, so that the errors in the thickness of the black may be made very small.

A series of observations made with different bolometers prepared in the same way gave results, the greatest variations of which were 0.6 per cent.

The above method shows it to be possible to define a light unit in terms of absolute units. It is, however, only a definition and not an expression for the unit in absolute terms. As the term light involves not only the energy of the vibrating particle but the physiological effect upon the retina it is impossible to express a light unit in absolute terms in the manner that we are able to express a unit of work. It is therefore impossible to express it in terms of C. G. S. system or at present in any known system, as we know that for lights of different colors, the effect produced is not proportional to the energy of the vibrations. The difficulty then lies in the comparison of different lights with a standard. It is well known that one of the greatest difficulties in photometric work is the comparison of lights of different colors. The composite thing known as light is, according to the generally accepted theory, made up of the action of a large number of different vibrations. Each vibration producing a different effect upon the eye and the relations of the intensities of the different vibrations determine the nature of the light source. This is shown in the different spectra produced by lights of different nature. We do not know the relative values of different colors in terms of the effect they produce upon the retina. We are then unable to compare the values of the two complex quantities without knowing the relative values of their component parts. In this sense we may say say that a light unit is impossible, and so far actual experience has shown it to be true. Attempts have been made to solve the question by using different standards for different colored lights. This would in a way obviate the difficulty, but would give us no standard unit, but different units without a knowledge of their relative values.

Any complete method of comparing two light sources is one that will take account of all colors which are contained in the sources. This implies the valuation of the different colors in terms of their physiological effect in enabling us to see objects about us. A complete unit is one the component parts of which are known so that the above comparisons can be made. We must therefore conclude that in its broadest sense we are very far from a complete solution of the problem of an absolute light unit, and so far that it is not even shown that in its complete sense such a light unit is possible.

OPERATING ELEVATORS BY DIFFERENTIAL MOTORS.

The Frazer Electric Elevator Company has an exhibition at its office, No. 232 Montgomery street, San Francisco, a model of a new type of high duty passenger elevator that it has under construction and which will soon be in operation in a well-known office building in this city. This elevator presents a marked deviation from all types of elevators now in use in that its motive power consists of two motors run differentially. The principle of operation will be understood by all who are familiar with the principle of the differential chain block, which, it will be remembered, has two different sized pulleys running at the same speed, and by means of which a powerful hoisting effort is obtained. In the Frazer elevator, however, the motors are equipped with pulleys of equal size, but the speed of the motors may be varied, thus giving a hoisting effort through suitable gearing.

A perfect understanding of the working principles the apparatus will be plain from the examination of the model, when it will be seen that the equipment possesses advantages by means of which many objectionable features of ordinary elevator construction are eliminated. Among its principal advantages may be enumerated, in addition to its low first cost, the facts that the motors never are started under load. They are never reversed and they are never stopped until the elevator car is at rest. As the speed is regulated within any limit by varying the resistance in the fild circuit of one or the other of the motors according to whether the car is raised or lowered, the controllr is of the utmost simplicity, consisting only of an ordinary field rheostat.

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The H. N. Cook Belting Company has secured the general Western agency for a number of specialties that are indispensible in high grade steam machinery, and among which may be named the Palmetto self-lubricating packing, which is considered the most durable fibrous packing mauufactured. For triple expansion engines it has no equal and it is specially adapted for engines, stop-valves and slip joints, where a high pressure and a high degree of heat exist. The materials entering into its composition are the very best, entirely free from grit and acid and being lubricated with the celebrated Manhattan compound, makes it practically indestructible.

The same concern also handles J. T. Wing & Co.'s high speed graphite metal for dynamos and general high speed engines and machinery bearings.

THE INTERIOR CONDUIT COMPANY AT THE ELECTRICAL EXPOSITION.

The exhibit being made by the Interior Conduit and Insulation Company at the National Electrical Exposition in New York City, is destined to be of great interest because of the novelties that will there be brought out and explained. The Lundell dynamo and motor equipments will again attest their excellence in widely diversified uses as the company will exhibit, for instance a large printing press in operation run by a direct connected Lundell motor. Special emery wheel grinder sets, buffing sets and organ blowing outfits will also be shown in practical operation, as will also an enormous illuminated sign. In addition, the company will exhibit its complete system of plain, brass armored and iron armored insulating conduits, as well as its complete underground conduit system for electric railways.

RECENT DOINGS OF THE WESTINGHOUSE CO.

A great many people who saw and admired the wonderful electric lighting machines furnished by the Westinghouse Electric and Manufacturing Company to the Columbian Exposition Company for the purpose of illuminating the World's Fair, were heard to remark at the time: "What will be done with these machines when the Fair is over?" It may be interesting for these people to learn that the Westinghouse Company recently furnished four of them to the United Electric Light and Power Company of New York City, and they are supplying 40,000 lights to a considerable portion of the metropolis. Several others are installed in the plant of the Brush Electric Light Company at Baltimore, while the rest of them are distributed in different large electric light plants throughout the country.

The Westinghouse recently shipped two of the largest electrical generators for the operation of an electric railway that have ever been turned out anywhere. These two machines were of 1,500 horsepower each, and they were contracted for by the Nassau Electric Railway Company of Brooklyn, N. Y. Last summer the company constructed and delivered to the same railway company three generators of 750 horsepower capacity each, making the total capacity of the electric railway plant 5,250 horsepower, one of the largest in the country. The new generators are of the style known as engine-type, being direct connected to a Cooper Corliss engine running at a speed of 75 r. p. m.

That the product of the Westinghouse Company is of world-wide demand has again been demonstrated recently by the company receiving orders to equip an electric railway in the Isle of Man, a little island near the coast of Ireland, which has been made famous by Hall Caine, the great novelist; another order for electric railway apparatus for the city of Coventry, England, and a third for Capetown, South Africa. The company is also about to ship an order for electric railway apparatus to Bangko, Siam, India.

The Lay Press.

POPULAR REFLECTIONS OF THE CONDITIONS AND PROSPECTS OF ELECTRICAL ENGINEERING ON THF PACIFIC COAST.

We can't have too much light—the more the better for our morals and esthetics.—Long Beach (Cal.) Breaker.

Electricians and progressive men in the towns of the San Joaquin and Sacramento valleys are watching with considerable interest the bill recently introduced by Representative Bowers in Congress to amend the act of March, 1891, granting a right-of-way upon public lands for reservoirs and canal purposes. The reason for this interest is said to be that the amendment is a measure demanded by the development of present conditions, or, more correctly, by the advancement of science in the application of electricity to manufacturing and agricultural enterprises. These men are mostly interested in the cities along the eastern side of the San Joaquin valley and the northern and eastern districts of the Sacramento. Other districts, notably Yolo county and the region around the lakes of Lake county are also watching the progress of this measure. It is held by the interested parties that the amendment will cause a revolution in manufacturing industries, and even in agricultural operations in the great valleys of California, as under present conditions the long stretches of government land and government reservations in the Sierras form an impassable barrier between the sources of power in the mountains and places where it may be utilized for the benefit of the people.—San Francisco Call.

There is nothing at which to be surprised in the announcement that Roentgen's ray is not new. Few discoveries are. It will be remembered that when Columbus thought he had found a continent he had merely dug up an old chestnut that Norsmen had been familiar with centuries before. Our best poets but pipe the lays of antiquity. The freshest jokes are only the withered fruitage of Eden. The most alluring and novel forms of crime were worn out by the ancients. Somebody had the nerve to patent a telephone, and was thereupon abundantly informed that it had been regarded as a household necessity among the Chinese before Confucius. Roentgen seems, like the rest, not to have been exploiting fresh fields, but merely to have lacked the modesty that so effectually prevented hundreds of scientists who knew all he did from imparting some small measure of it to the public. If these scientists are withholding other valuable information—and doubtless time will demonstrate that they are—now is the opportunity to spring it while the popular mind is in a receptive mood.—San Francisco Examiner.

Enemy of the fender,
Foe of the transfer,
Terror of the small boy
Who nips the pasteboard
And makes it, to your woe,
A thing of barter—
Otherwise, Sir Vining, hail!
Once more a pleasant greeting,
Again the loan of your eye
(If it can be unglued
From the elusive nickel);
'Tis said your heart
Is like to break
Under a load of grief
Produced by words unkindly,
And that you cuss amain;
So we, to ease your pang
Pipe but a gentle note.
Beware a broken heart.
If yours be rent to bits
A cathode ray applied
Would show your person
Chockful and paralyzed
With marble-dust.
Hence you must try to smile
E'en though a fare
May now and then escape you.
Think little of traducers,
But of the fun you have
With fenderless and fearsome car
To chase the citizen
And often catch him;
The boon of watching patrons
Hanging aswing from straps,
Elbowed by conductors,
Trodden as to corns,
And sassed if they protest.
The blithsome glee is yours
To stop our transfers,
Gobble our streets,
And tell them who object
To go to, straightway.
Why sure you have a liberal share
Of earthly joy,
And no kick coming,
Even when forced to fib
We know 'tis simply Collis
Fibbing vicariously.
So brace up, Vining.
Be gay and give your critics
That which is sometimes called
By vulgar folk, the merry ha ha.

—San Francisco Examiner.

Electrical power is only in its infancy. When a network of wires takes cheap power into every remote corner of Mariposa county, the development of gold quartz-mining in this district will astonish the civilized world.—Mariposa (Cal.) Gazette.

Kingman will yet be the center of one of the greatest mining sections of the United States, and projected electric lines will be the means of making it one of the largest and most prosperous cities in the territory. As soon as the projectors of the new company have been consulted with we will give an outline of the contemplated work and its great advantages to Mohave county at large.—Kingman (Ariz.) Miner.

Reports of the Month.

Personal

Mr. C. A. Coffin, President of the General Electric Co., has been paying a hurried visit to the Pacific Coast.

M. A. L. Brayton, Secretary and Treasurer of the Pelton Water Wheel Co., is on a business trip to Honolulu, H. I.

Mr. E. Peckham, President of the Peckham Motor Truck and Wheel Co., has been spending several weeks in Los Angeles, accompanied by his wife.

Mr. Geo. A. Steel, President and Manager of the Westside Electric Railway Co. of Portland, Or., has returned home, after several weeks' sojourn in California.

Mr. Robert H. Postlethwaith, late electrical engineer of the New Zealand Engineering and Electrical Co. of Dunedi, N. Z., has located at Carrville, Trinity Center, Cal., temporarily.

Mr. T. C. Martin, Past President of the American Institute of Electrical Engineer and editor of the "Electrical Engineer," has been appointed representative of the Institute to take part in celebrating the jubilee of the professorship of the Right Honorable Lord Kelvin in Glagow on June 15th and 16th.

Mr. S. Mine, Electrician to the Department of Communications, together with Messrs. Y. Wadachi and R. Nakayama, Engineers to the Department of Communications, are at present in San Francisco, but will shortly leave for a tour of America and Europe for the purpose of studying the various applications of celectricity. Mr. Mine is restricting his inquiries to electric railways and the electric transmission, while the other gentlemen will devote their time to telephony and telegraphy.

COMMUNICATION.

Stockton, Cal.—The new Gamewell Fire Alarm system now being installed is to be operated from Storage battery.

Phoenix, Ariz.—The Council is considering a proposition from the Gamewell Fire Alarm Telegraph Co., for maintaining the Fire alarm service.

San Bernardino, Cal.—Chas. D. White has resigned the local managership of the Sunset Telephone & Telegraph Co., to resume his electrical construction and supply business, and Chas. D. Burnell has been appointed to the vacancy.

Oakland, Cal.—An ordinance has been introduced in which a license of $1 per month is imposed upon telephones with "nickel in the slot" telephones on a plane with the nickel in the slot machines used as games of chance.

Portland, Or—The Columbia Telephone & Telegraph Co., has been popularizing its system by giving "Telephone Concerts" in which musicians in various cities along the line of the Willamette Valley Telephone Company participate. The concerts are a great success.

LITIGATION.

Portland, Or.—A jury in the case of W. T. Perham vs. the Portland General Electric Co. has rendered a verdict for $4,500 to the plaintiff for the death of M. C. Perham, a carpenter employed in the repair of a bridge over which 5,000-volt circuits of the defendant were run and who was killed by contact therewith on September 27th, 1893. The action was by Messrs. Reed & Hogue, attorneys, begun on the ground of alleged negligence on the part of the defendant corporation in maintaining high potential wires in a position where workmen

on top of the bridge would be obliged to come in contact with them, in failing to sufficiently insulate the wires and in not notifying the workmen that current would be turned on when the Company knew the men were at work on the bridge. The defense set up the claim of the impracticability of insulating currents of such high voltage as to make contact with the wires safe, together with negligence on the part of the decedent's employer and contributing negligence on the part of decedent. In delivering his charge to the jury upon the question of negligence and contributory negligence, the Judge said: "Some question may be raised about what degree of negligence or what degree of care may be considered as a caust of action, or as exemption from liability. On that subject I instruct you that care or diligence are relative terms; they are not absolute terms, but they are controlled and con escape the consequences of danger must be proportionately action. Where the danger is great the care and diligence to escape the consequences of of danger must be proportionately great. In matters of this sort, where people are dealing with electricity, one of the most subtle, powerful and wonderful agencies known to man, an agency that is very destructive to human life even when carefully and properly handled and treated, I instruct you in such case as this due care would be the highest care and vigilance of which a man is capable and which the condition of science makes known at the time, and that is the degree of care which was demanded of this company, to so conduct itself in regard to its wires on that bridge as that the diligence and care should be proportionate to the danger which there existed." The case has been appealed to the Supreme Court.

INCORPORATION

Oakland, Cal.—The Electric Specialties Company incorporated by A. C. Robbins, Chas. P. Visher, G. F. Burtchaell, Dan'l Crowley and D. F. Jones.

San Francisco, Cal.—The Edison Light and Power Company and the San Francisco Gas Light Company have consolidated and a new corporation is to be formed with a nominal capital of probably $15,000,000.

Los Angeles, Cal.—The San Mateo street and Santa Fe avenue Street Car Company have elected a new directory consisting of Abbott Kinney, President; John D. Pope, D. L. Graves, C. S. Day and C. A. Sumner, Secretary.

Santa Barbara, Cal.—The Santa Barbara Consolidated Electric Company has been re-organized with a capital stock of $500,000. The officers are C. W. D. Miller, president; A. Hope-Deog, vice-president; H. S. Luster, secretary and treasurer.

City of Mexico.—Unconfirmed statements are being made that the electric light plant of the Indianilla race course had been passed into the hands of strong company of United States capitalists and incorporated.

Redwood City, Cal.—Redwood City Electric Light Company. Incorporators and directors: Chas Joslyn, Geo. C. Ross, Geo. H. Rice, Robert Brown and L. P. Behrens. Objects: To succeed to the interest of the Redwood City Electric Company.

Salt Lake City, Utah.—Salt Lake and Ogden Railway Company, capital $800,000. Objects, to build and operate 40 miles of railroad between Salt Lake City and Ogden. Directors: C. K. Bannister and E. M. Allison Jr. of Ogden; E. W. Duncan, J. S. Critchlow and Causten Brown, Jr., of Salt Lake. It is stated that the Pioneer Power Company of Ogden is really at the head of the enterprise.

TRANSMISSION.

Bingham, Utah.—The Dalton & Lark Company proposes to operate its mining plant by electric power.

Bakersfield, Cal.—The contract for the installation of the transmission plant of the Power Development Co. has been awarded to the General Electric Co.

Grass Valley, Cal.—The Fortuna mines, at present using steam power, will shortly adopt water power or install an electric transmission plant.

Spokane, Wash.—The Le Roi Mining and Smelting Co. has issued specifications for a 450 h. p. air compressor driven by twin compound Corliss engines.

Nevada City, Cal.—The Stanley Electric and Manufacturing Co. have been given orders for one 120 k. w. two-phase Stanley motor for use in the Gold Hill mine.

Hanford, Cal.—The Keweah Irrigation and Power Co. is at present paying more attention to irrigation than to the development of its electric power projects.

San Diego, Cal.—Judge Puterbaugh has filed a claim of 50,000 inches of water in the San Luis Rey River, which he proposes to utilize for electrical transmission purposes.

Antioch, Cal.—The Empire Coal Co. Belshaw mine has just installed a 2½ h.p. Westinghouse multipolar 125 volt dynamo for operating lights in the Empire coal mine, the transmission being 3000 feet.

Angels, Cal.—The new company that has secured control of the Sheep Ranch mine is breaking ground on San Antone Creek for an electric transmission plant to operate the mine.

Sonora, Cal.—The General Electric Co. is installing a three-phase induction motor for operating the hoist at the Rawhide mine. The Tolumne Electric Light and Power Co. is now in regular operation.

Merced, Cal.—I. H| Jacobs of San Francisco, owner of the water power of Merced Falls, has been looking over the prospect of transmitting electric power to this place, but has reached no conclusion as yet.

Pomona, Cal.—Single phase synchronous motors are being used here on the single phase circuits of the San Antonio Light & Power Co. The head of water at the power house of the company has been increased 50 feet.

As an inducement to come to Riverside, the City Trustees have offered the Connecticut Shoe Factory electric power at the rate af $1 per h. p. per month for day power for the first year, and after that $2.

Mariposa, Cal.—H. H. Clark, General Manager of the Bend Power Co., has requested mine owners and other probable power consumers to state their requirements so that adequate machinery may be installed at the outset.

Yreka, Cal.—Work on the Big French Creek ledge has been suspended, owing to the cost of water power, and the mining company proposes to install a transmission plant to be operated by water it owns, the power of which is unavailable at present.

Marysville, Cal.—W. W. Waggoner of Nevada City has located all the available water at the narrows of the Yuba River, and proposes to bring about its utilization in irrigation and electric power transmission in Smartsville, Marysville and Wheatland.

Ione, Cal.—The Blue Lakes Water Co. has about perfected arrangements for its transmission plant which will be located at Tripps Mill. It is claimed that 20,000 h.p. is available, as much of which as required will be transmitted to the mines in the vicinity and Stockton.

ILLUMINATION.

Mendocino City, Cal.—An electric light plant is talked of.

Spokane, Wash.—Gas is to supersede electric light in the Court House.

Murphys, Cal.—The capacity of the electric light plant is to be increased.

Petaluma, Cal.—A cold storage and ice plant has been added to the electric light works.

Crescent City, Cal.—A. A. Barneburg has applied for a 20 year electric light franchise.

Ben Lomond, Cal.—T. L. Bell is to install an isolated plant for lighting his residence.

Zamora, Mexico.—Francisco Celoso Garcia is endeavoring to erect an electric lighting plant here.

Sanger, Cal.—The Sanger Lumber Co. is installing a 25 light arc dynamo at its mountain mills.

Palo Alto, Cal.—The incandescent circuits of the Redwood City Electric Co. have reached this place.

Reding, Cal.—A 1000 light Westinghouse alternator has been added to the plant of the Redding Electric Light Co.

Santa Ana, Cal.—E. C. Sharp of Riverside has been appointed consulting engineer for the proposed municipal plant.

Berkeley, Cal.—The grounds of the University of California are now lighted by electricity from the University plant.

Mercur, Utah.—The plant of the Mercur Electric Light & Power Co., is about ready to begin operations. Geo. Brown is Manager.

Fresno, Cal.—The San Joaquin County hospital will be lighted with incandescent lamps operated by the San Joaquin Electric Co.

Grass Valley, Cal.—The Nevada County Electric Power Co., has bought the plant and interests of the Grass Valley Electric Lighting Co.

Hermosillo, Mexico.—It is stated that a new company in which Governor Corral is interested will soon establish an electric light plant here.

Tucson, Ariz.—The Tucson Electric Light Co. is at present operating 1,800 incandescents and 18 arc lamps. Wood fuel is used, costing from $15 to $18 per day.

Nevada City, Cal.—The City Trustees have accepted the proposition of the Nevada County Electric Power Co. to furnish the city 55 all night street incandescant lamps for $100 per month.

Long Beach, Cal.—The new 125 h.p. Ball tandel compound engine is now in operation at the electric light plant and service is being rendered for about 1400 lights in Long Beach, San Pedro and Wilmington.

Grass Valley, Cal.—The Nevada County Electric Power Company has purchased the plant, business and good will of the Grass Valley Electric Light Company from John Glasson, its owner. This will cause the abandoning of the old plant on Deer Creek, as the service will hereafter be rendered from the light and power transmission circuits (Stanley system) of the Nevada County Company.

Mazatlan, Mexico.—The local press states that the Mazatlan Gas Co. charges exorbitant rates as a result of which the municipality has become indebted to it to the extent of $100,000 on which the company charges 12 per cent. interest. The residents of Mazatlan have, therefore, petioned the governor to award the public lighting contract to an electric light company, that has just started business in Mazatlan, or to call for tenders for the service.

Los Angeles, Cal.—The West End Electric Lighting Co., which was installed by E. E. Peck just outside the city limits but which has now become incorporated within the city owing to the recent extension of the city limits, has secured the

City of Mexico, Mexico.—The isolated plant for lighting the h.p. Corliss-Fishkill engines, two 75 h.p. Bass Corliss boilers National Palace is now in operation. It consists of two 60 and one 37.5 kw. Westinghouse multipolar generator. The incandescent lamps used are of 8 cp., and the engines also operate the machinery in the stamp engraving department. The plant which was installed by Mr. J. Sternefeld, chief engineer for the engineering firm of G & O. Braniff & Co., was inaugurated by President Diaz with much ceremony.

MISCELLANEOUS.

Berkeley, Cal.—An ordinance has been enacted prohibiting the stretching of electric wires, and the erection and maintenance of pole lines in this town, "except by and with the consent of the Board of Trustees, and under such rules and regulations as may hereafter be prescribed."

Nevada City, Cal.—Charles L. Ferris, a native of Colorado, and 47 years of age, was instantly killed at Providence mine on March 26th by an electric shock. Ferris was a lineman in the employ of the Electrical Construction & Repair Company, and in starting to descend from a pole one of his climbers slipped and, in throwing out his arms to recover himself, he bridged a 2,000-volt circuit.

Sacramento, Cal.—A severe thunderstorm visited this section on March 27th, when lightning struck the transmission circuits of the Sacramento Electric Power & Lighting Company, entering the Folsom power-house and necessitating the stoppage of the plant for four hours. The lightning arresters designed for the protection of the system had not been erected by the contractors, owing to the infrequency of lightning in this vicinity, and to this inattention is attributed the damage wrought. Several poles on Twenty-eighth street in Sacramento were splintered, but no further material damage ensued.

Anaconda, Mont.—One of the largest electro-deposition plants in the world has just been erected here in the works of the Anaconda Copper Company. It consists of two triple-expansion vertical engines, built by the Union Iron Works of San Francisco, to each of which is directly connected two 270 kw. special Westinghouse generators. The engines are run condensing at a boiler pressure of 150 pounds at 150 r. p. m. The generators are 14 pole machines, and each delivers 3,600 amperes at 75 volts, the current being taken from each machine by 98 carbon brushes. The plant is used for the electrolytic refining of copper.

San Francisco, Cal.—M. A. Rothschild, President of the Gerlach Wave Motor Company, states that the wave motor described in the Journal for January is in running order, and is developing as high as 180 h. p. The company, however, is not satisfied with the location of the apparatus, which is in a bay at Capitola, rather than on the ocean beach, and until a better location can be secured nothing will be done towards utilizing the power. The directors have not yet determined upon the means by which the power will be utilized.——The Board of Supervisors has passed an ordinance amendatory of section 115 of order No. 2,927, requiring that wires used for electric or other purposes, when over six in number and bunched, shall be enclosed in a metal tube within buildings, and that main service switches located at or convenient to the main entrances of buildings shall be placed in all premises using electric light, heat or power.

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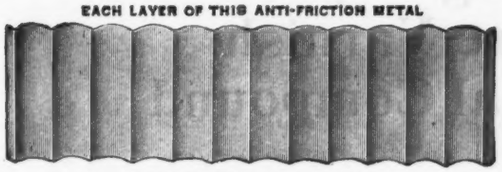

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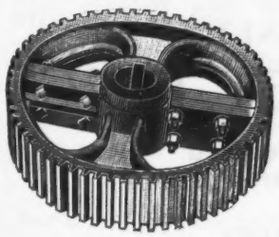

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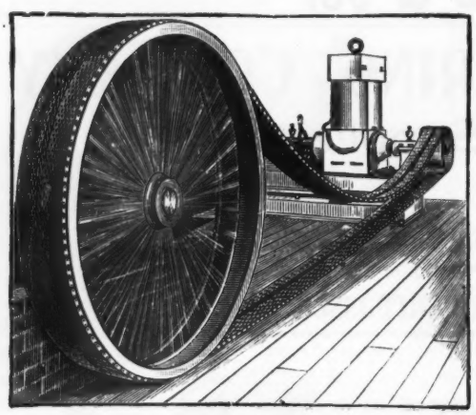

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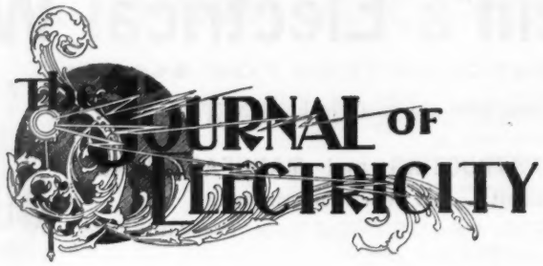

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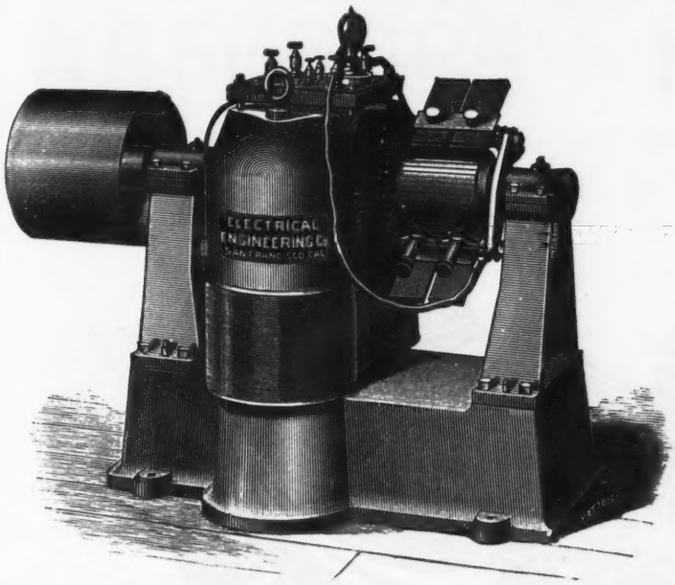

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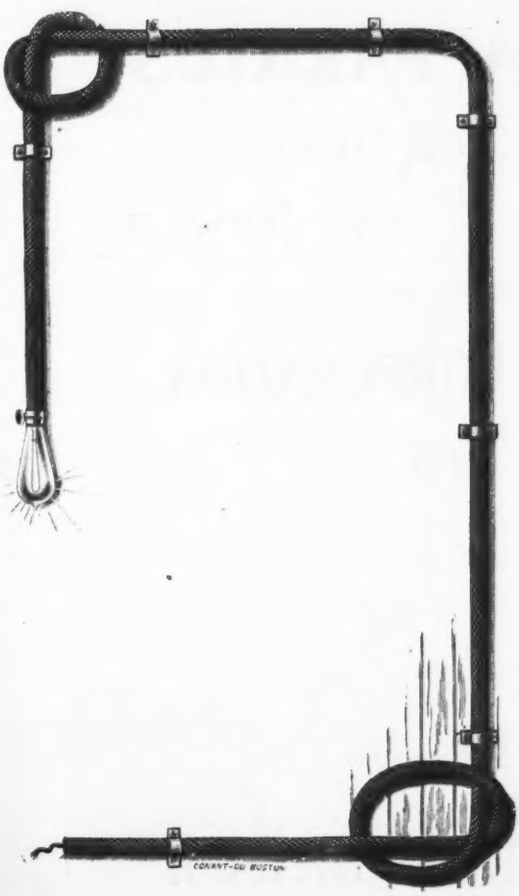

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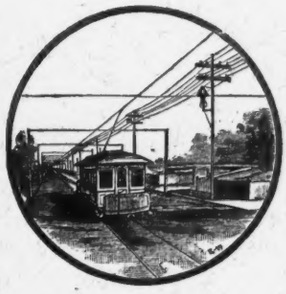

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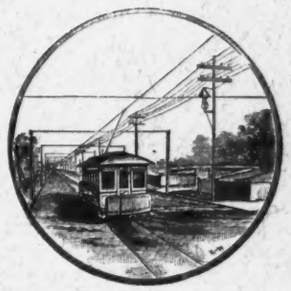

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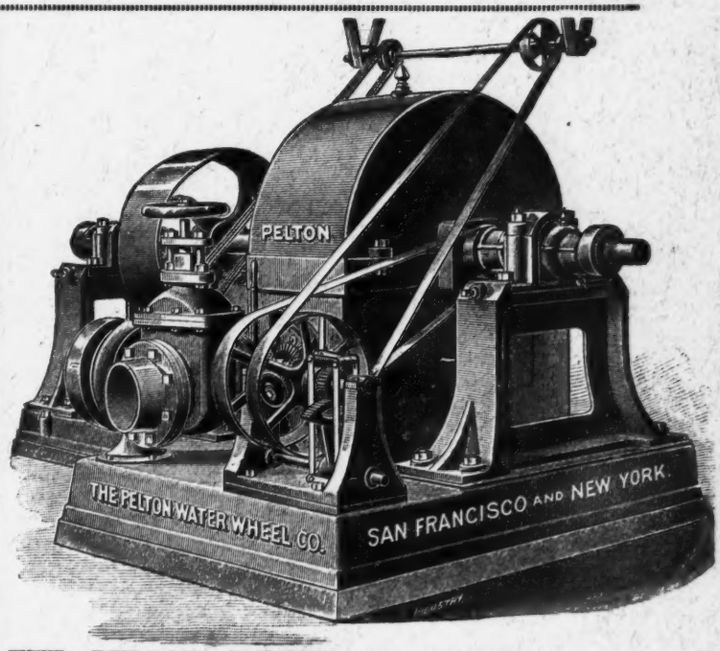

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